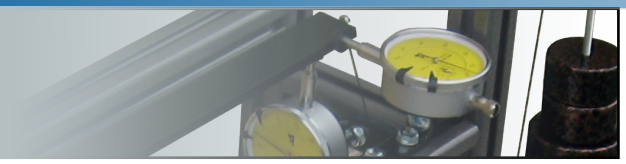
Basic knowledge

STRESS AND STRAIN



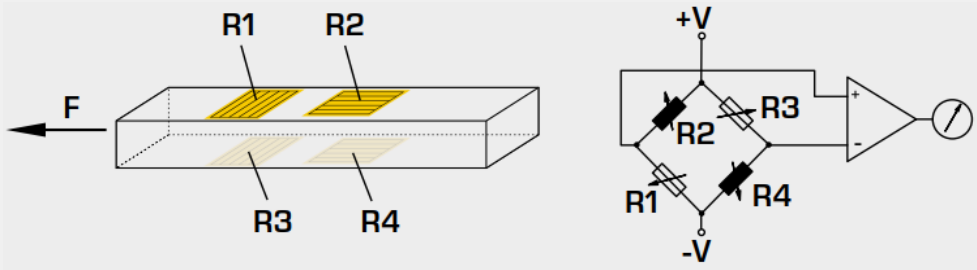
When components with specific dimensions are subjected to mechanical loads to perform their function, it is important to understand the nature of these loads. In particular, it is necessary to determine the maximum stresses that occur, as these ultimately define the dimensions. These stresses should be identified in advance and verified experimentally. Therefore, experimental stress and strain analysis can be regarded as a link between theoretical calculations and experimental evidence.
This section presents a non-destructive experimental method of analyzing stress and strain: the electrical method of deformation measurement using strain gauges to indirectly determine the actual stresses.

Strain measurement using strain gauges

Stresses in components can be determined via the circuitous route of strain measurement, as the strain of the material is directly related to the material stress. An important branch of experimental stress and strain analysis is based on the principle of strain measurement. The advantage of this method is that strain gauges can be used on real components in operation.
Strain gauges comprise resistance wires that are adhered to the surface of the workpiece. If the surface is extended, the wire is lengthened and its cross-section decreases. This increases the electrical resistance. In the case of compression, the resistance decreases. In a Wheatstone bridge, the resistors are connected as a voltage divider. The measuring circuit is particularly suited for measuring small changes in resistance and, therefore, for determining the resistance change of a strain gauge.

Determining the magnitude and direction of mechanical stresses

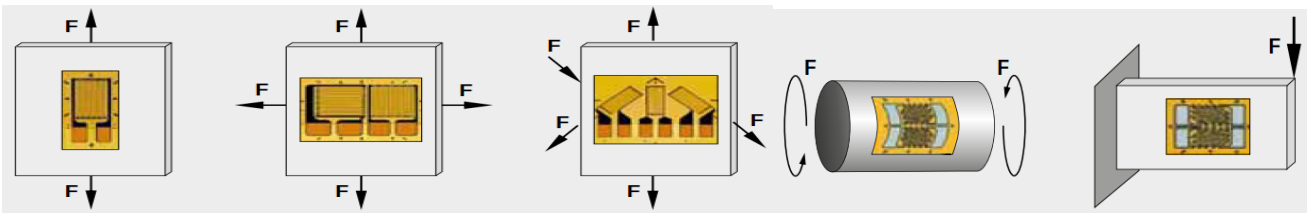
Using the generalised Hooke's law, we can calculate the stresses σ from the strain ε measured at the surface.



Measuring the strain to determine the tensile stress

R2 + R4 measurement of longitudinal strain,
R1 + R3 measurement of lateral strain, F force

Selecting and installing the strain gauge to investigate different stress states



Uniaxial stress state such as tension or pressure

Biaxial stress state

Unknown direction of principal stress

Torsional strain

Shear stress in the neutral strand

Different structural shapes for different applications

F force