The theory of the foil strain gage

1. The Dictionary Definition of Foil Strain Gage

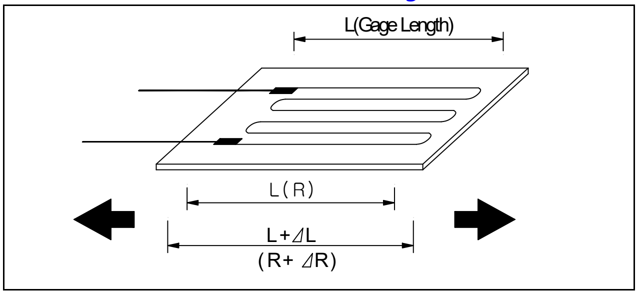
Let me introduce 'strain' first in order to explain the strain gage. Strain refers to 'strain intensity' or 'strain' and means the value that the length increased or decreased compared to the original length is indicated into a rate when an object is subject to tension or compression. Therefore, the strain does not have any unit, but it may be indicated by such units as cm/cm, mm/mm it is really necessary to indicate those units. This strain is a term used when these elements of structures are transformed by outer forces mainly in the fields that deal with the interpretation and designs of structures or mechanical elements such as civil engineering, mechanical engineering, architectural engineering, aeronautical engineering, marine engineering, etc.

2. The Principle of the Strain Gage

The strain gage is a sensor that detects a minute mechanical change(strain) with electrical signs. It can measure the minute dimensional change namely, the strain, that occurs at its surface when it is attached to the surface of machines or structures and find out the internal stress important for confirming the intensity or safety from the value.

The strain gage is an application that uses a resistance. Resistance elements have a characteristic that the change rates of length(strain: ε) and those of resistance are proportional to each other, and it is a device that just applies this characteristic. And the proportion between the change rates of length(strain) and change rates of resistance is called 'gage factor' and it uses the value provided by strain gage manufacturers. The strain measured is indicated as an output voltage of a bridge circuit, but actually, it measures the change of resistance, and so, if only there is a Gage Factor, we can obtain the strain from the change rates of resistance

3. General Forms of the Strain Gage



The length change of a gage(△L/L), the strain(ε) is proportional to the change rates of resistance(△R/R). Therefore, there is a Gage Factor.

$$\mathbf{G.F} = \frac{\mathbf{\Delta B/R}}{\mathbf{\Delta L/L}} = \frac{\mathbf{\Delta R/R}}{\boldsymbol{\varepsilon}} \quad \therefore \mathbf{\Delta R/R = G \cdot F * \varepsilon}$$

4. Explanations of Terms In the Correction of the Strain Gage

■ Strain

The limit of internal stress that has an elasticity in an object is called "Elastic Strain". The value that compares with the degree of transformation as an amount of transformation for a unit length, which means, namely, the rate between the amount of transformation and an original dimension, is called 'Strain' and though its unit is a dimensionless number as a concept of ration, it can indicate the value as % by multiplying 100.

■ Gage Factor

This means a proportional constant used as a meaning of a gage constant that is produced in the relation between measured values indicated by measuring instruments and engineering units such as forces, loads, internal stress, displacements and angles, etc. and we can convert the measured values into engineering units by multiplying the 'Gage Factor' and the measured value.

■ Nature of Linearity

This means the rate between outputs without loads and a line connected with outputs under rated loads in a corrective curve.

■ Hysteresis

This means percentage that divide the maximum difference of outputs in case of both increase and decrease from being without loads to the rated loads by rated outputs.

■ Insulation Resistance

When applying direct currents to an insulator, .

■ Voltage Withstand

This means the degree to which machines or their parts can withstand voltage and is a test that evaluates or guarantees their ability to withstand high voltage that is as a few times as the voltage used.

■ Sensitivity

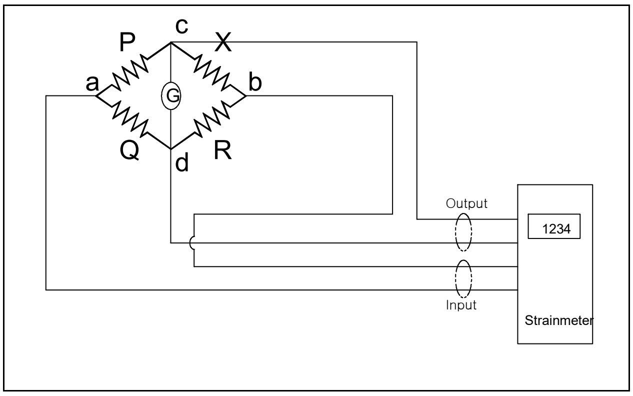
This means the least unit that can indicate measuring instruments by the degree or ability to receive output signals of measuring instruments and is usually used as a similar concept to the 'Resolution'

5. Wheatstone Bridge Circuits

When making four (4) resistances as shown in the below-indicated figure by connecting them symmetrically and applying voltages after installing a current indicator, a drop of electrical pressure occurs for each resistance because currents are flowing into the circuit. If the voltages at middle points of c-d with which a current indicator is connected are the same, potential value becomes "0" and currents do not flow, and thus, the current indicator points out the middle point. In this case, the difference of voltages becomes the same(equilibrium). A drop of electrical pressure for each resistance is proportional to the size of resistance. A drop of electrical pressure in resistance is proportional to resistance and the proportion of resistance becomes the proportion of voltage, and thus, we can obtain an unknown resistance using this. The values multiplying the resistances facing each other are the same. In this case, we can use the equation, PR = QX.

The change of resistance that occurs where the strain gage adhered is under strain is extremely small. For example, where the strain of 1000 X 10^{-6} is applied to the strain gage whose Gage Factor is 2, △R of the strain gage whose resistance values is 120Ω is just a 0.24Ω. The strain gage is usually used within the Wheatstone bridge circuit in order to efficiently convert such a small change of resistance into electrical signals. In this case, you can remove '0 movement' to temperature or obtain only one signal that you want to depending on how you make the Wheatstone Bridge Circuit. If you make the Wheatstone Bridge Circuit and attach it to cells, eccentric loads are corrected for each gage; they are produced as regular loads; and thus, you can automatically correct the change of temperature.

.



6. Calculation in Case of the Strain Gage (Full Bridge Circuit)

*** Actual Value Measured =**
(Current Value Measured – Initial Value) x Gage Factor

■ Initial Value – This means the outputs without loads where the outputs of a sensor using the strain gage.