5. Basic Circuit of Load Cells

When a force is applied to a load cell the electrical resistance of the strain gauges attached to the spring material will vary. This change in the resistance value is measured in volts. As the resistance change of the gauges is very small, a Wheatstone Bridge is generally used, as illustrated in 2.12

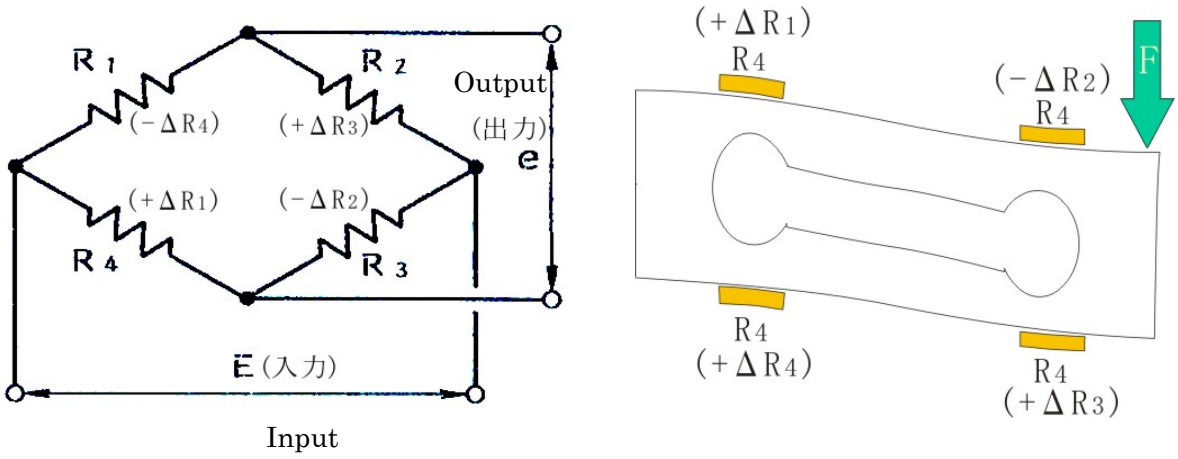

Figure 2.12. Wheatstone Bridge

5.1. Wheatstone Bridge

The Wheatstone Bridge is an electrical circuit that is ideal for detecting minor changes in resistance. It is also used to measure changes in the resistance of a strain gauge. The Wheatstone Bridge is the combination of four resistors as shown in Figure 2.12. Gauges R_1, R_2, R_3, R_4 are bonded to the positions shown in Figure 2.12 above and they serve as bridges. The output voltage before loading can be obtained as follows:

$$e = \frac{R_1 R_3 - R_2 R_4}{(R_1 + R_2)(R_3 + R_4)} e_{in} \qquad (e_{in} : \text{Input voltage})$$

When the gauges connected to the four sides of the bridge are strained, each side R_1, R_2, R_3, R_4 is changed slightly, and the strains $+\Delta R_1$, $-\Delta R_2$, $+\Delta R_3$, $-\Delta R_4$ are generated. The output voltage at this moment can be expressed using the following equation:

$$\Delta e = \left\{ \frac{R_1 R_2}{(R_1 + R_2)^2} \left(\frac{\Delta R_1}{R_1} + \frac{\Delta R_2}{R_2} \right) \right\} e_{in} + \left\{ \frac{R_3 R_4}{(R_3 + R_4)^2} \left(\frac{\Delta R_3}{R_3} + \frac{\Delta R_4}{R_4} \right) \right\} e_{in}$$

Here, $R_1 = R_2 = R_3 = R_4$ holds true, and in the case of the Roberval structure,

$|\Delta R_1| = |\Delta R_2| = |\Delta R_3| = |\Delta R_4|$ is also true. Therefore,

$$\Delta e = \frac{\Delta R}{R} e_{in}$$

$$\Delta R = K \cdot R \cdot \varepsilon$$

$$\Delta E = K \cdot e_{in} \cdot \varepsilon$$

and the output voltage (Δe) is proportional to the strain (ε).