DERIVATION OF GAUGE FACTOR

The gauge factor is defined as the unit change in resistance per unit change in length.

It is denoted as K or S. It is also called sensitivity of the strain gauge.

$$S = \frac{\Delta R/R}{\Delta l/l}$$

S = Gauge factor or sensitivity

R = Gauge wire resistance

ΔR = Change in wire resistance

l = Length of the gauge wire in unstressed condition

Δl = Change in length in stressed condition.

Derivation: Consider that the resistance wire is under tensile stress and it is deformed by ~*I* as shown in the Fig.

When uniform stress (J is applied to th.is wire along the length, the resistance R

Let ρ = Specific resistance of wire material in Ω-m

l = Length of the wire in m

A = Cross-section of the wire in m^2

changes to R + ~R because of change in length and cross-sectional area.

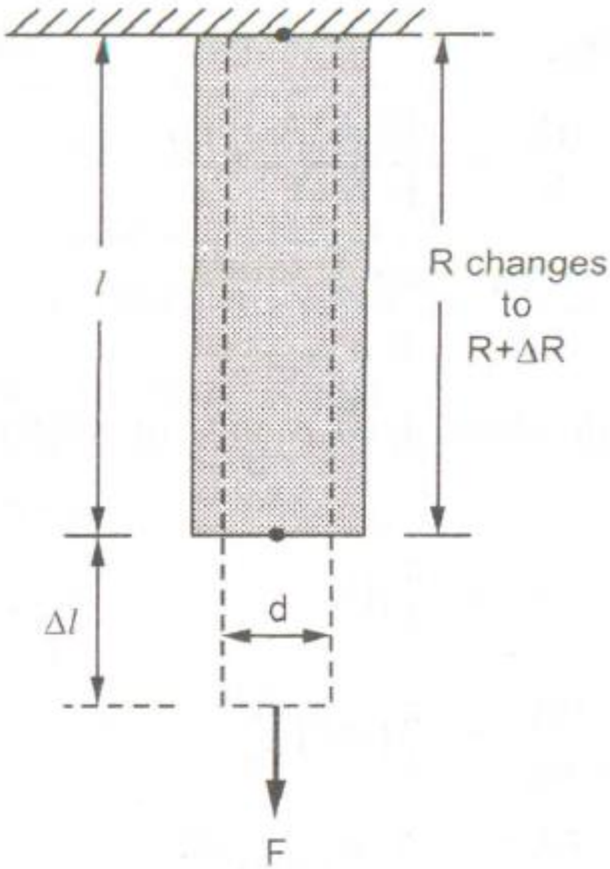
$$\sigma = \text{Stress} = \frac{\Delta l}{l}$$

$\Delta l/l$ = Per unit change in length

$\Delta A/A$ = Per unit change in area

$\Delta \rho/\rho$ = Per unit change in resistivity (specific resistance)

$$R = \frac{\rho l}{A}$$



$$\therefore \qquad \frac{dR}{d\sigma} = \frac{d\left(\frac{\rho l}{A}\right)}{d\sigma} = \frac{\rho}{A}\frac{\partial l}{\partial \sigma} - \frac{\rho l}{A^2}\frac{\partial A}{\partial \sigma} + \frac{l}{A}\frac{\partial \rho}{\partial \sigma}$$

Note that $\qquad \frac{\partial}{\partial \sigma}\left(\frac{1}{A}\right) = -\frac{1}{A^2}\frac{\partial A}{\partial \sigma}$

Multiply both sides by $\frac{1}{R}$,

$$\frac{1}{R}\frac{dR}{d\sigma} = \frac{\rho}{RA}\frac{\partial l}{\partial \sigma} - \frac{1}{R}\frac{\rho l}{A^2}\frac{\partial A}{\partial \sigma} + \frac{l}{RA}\frac{\partial \rho}{\partial \sigma}$$

Using $\qquad R = \frac{\rho l}{A}$ on right hand side,

$$\frac{1}{R}\frac{dR}{d\sigma} = \frac{1}{l}\frac{\partial l}{\partial \sigma} - \frac{1}{A}\frac{\partial A}{\partial \sigma} + \frac{1}{\rho}\frac{\partial \rho}{\partial \sigma}$$

Canceling $\partial\sigma$ from both sides,

$$\frac{dR}{R} = \frac{dl}{l} - \frac{dA}{A} + \frac{\partial\rho}{\rho}$$

i.e.
$$\frac{\Delta R}{R} = \frac{\Delta l}{l} - \frac{\Delta A}{A} + \frac{\Delta\rho}{\rho}$$