FACULTY OF MECHANICAL ENGINEERING | institute of solid mechanics, mechatronics and biomechanics

Experimental mechanics (REM)

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Elaboration date:	17.1.2019	
Assigment name:	**Apparent deformation**	
Supervisor	Ing. Petr Krejčí, Ph.D.	Evaluation:

Assignment

Identify effect of temperature on strain gauges that are temperature compensated on metal (steel/aluminium) and plastic when placed on alumimium, steel and plastic.

Compare obtained values with real strain caused by temperature change of sample.

Experiment

Overview

Temperature change during measuring cycle causes change of reported value in each strain gauge. This is enhanced by other factors that are impacting measurement due to temperature change:

- α_S - strain caused by temperature change
- α_G - change of grid in dependence on temperature
- β_G - resistance change in dependence on temperature

Apparent deformation ϵ_z can be derived from resistance response of strain gauge caused ΔT.

$$k * (\alpha_S - \alpha_G) * \Delta T + \beta_G * \Delta T = k * \epsilon_z = \frac{\Delta R}{R} \tag{1}$$

$$\epsilon_z = [(\alpha_S - \alpha_G) + \frac{\beta_G}{k}] * \Delta T \tag{2}$$

Parameters

Measuring equipment:

- Central – HBM MX840A Quantum
- Strain Gauge Amplifier – HBM MX1615B Quantum

Thermal expansion coefficient:

- aluminium: $\alpha = 12.62 * 10^{-6}\ K^{-1}$
- steel: $\alpha = 23.88 * 10^{-6}\ K^{-1}$
- plastic: $\alpha = 64.28 * 10^{-6}\ K^{-1}$

Measurement

Data was measured by combination of three temperature compensated strain gauges with three different materials (aluminium, steel, plastic). Those strain gauges were placed on small plates of material and heated from ambient temperature to 45 C (see fig. 1).

Below are desired graphs showing effect of increasing temperature on strain gauges placed on different materials.

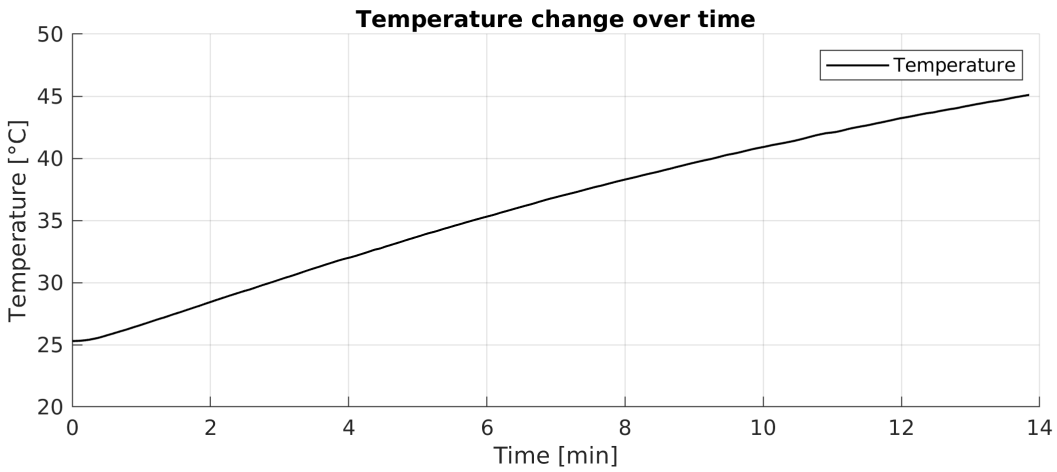


Figure 1: Temperature change over time

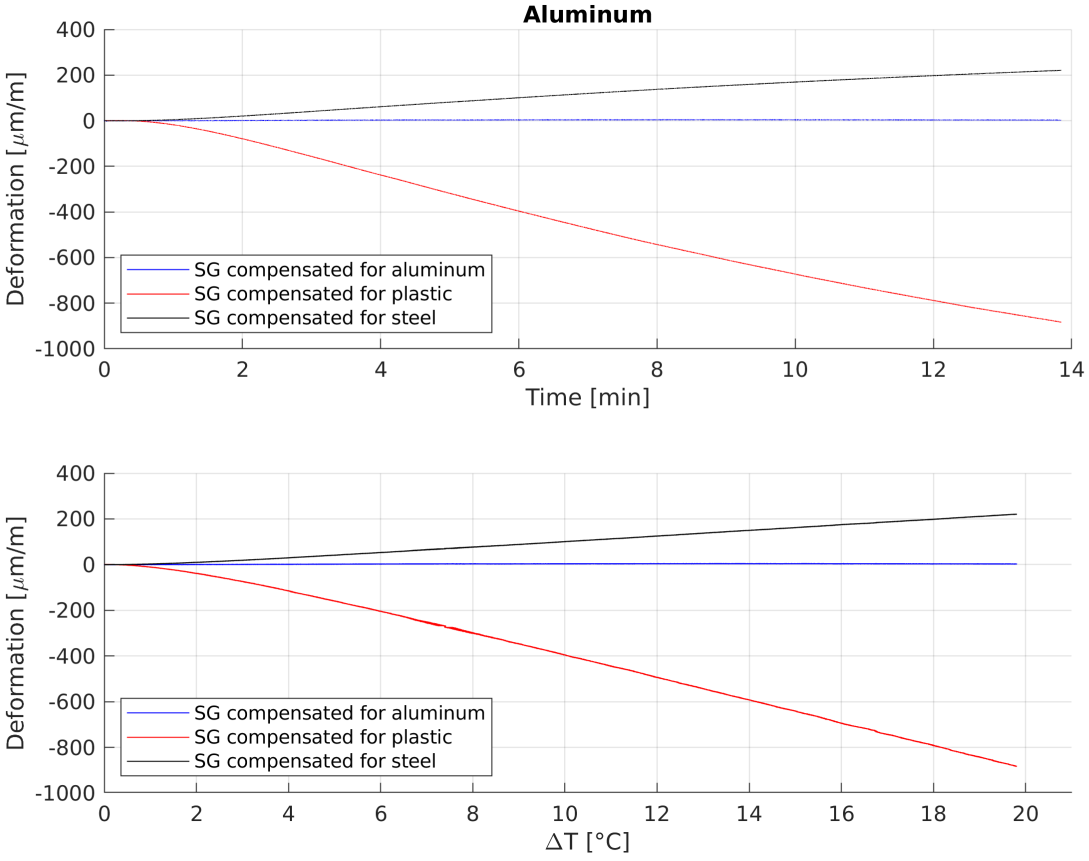
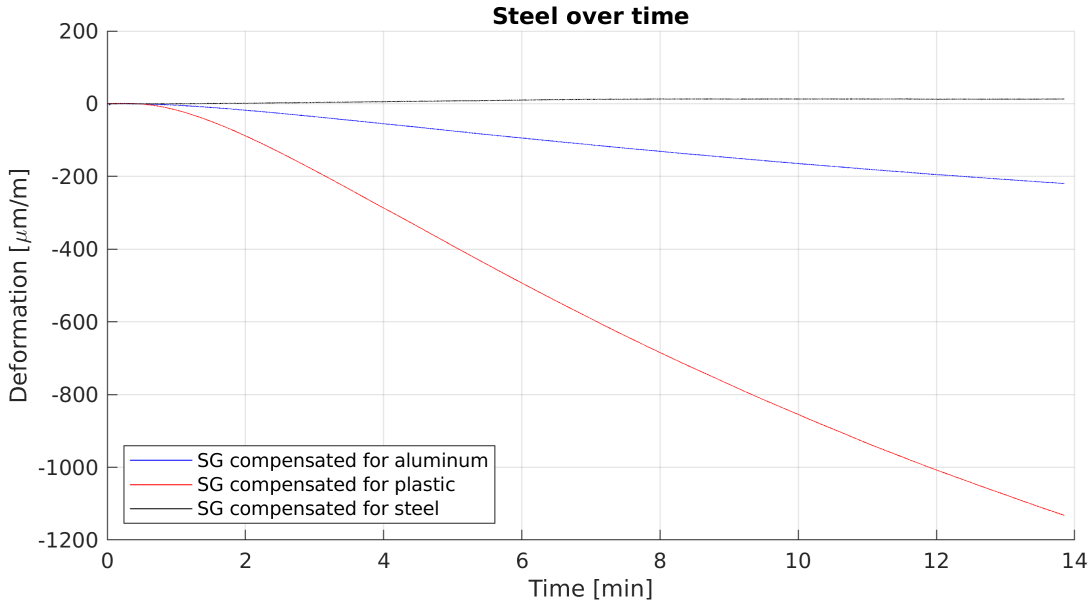
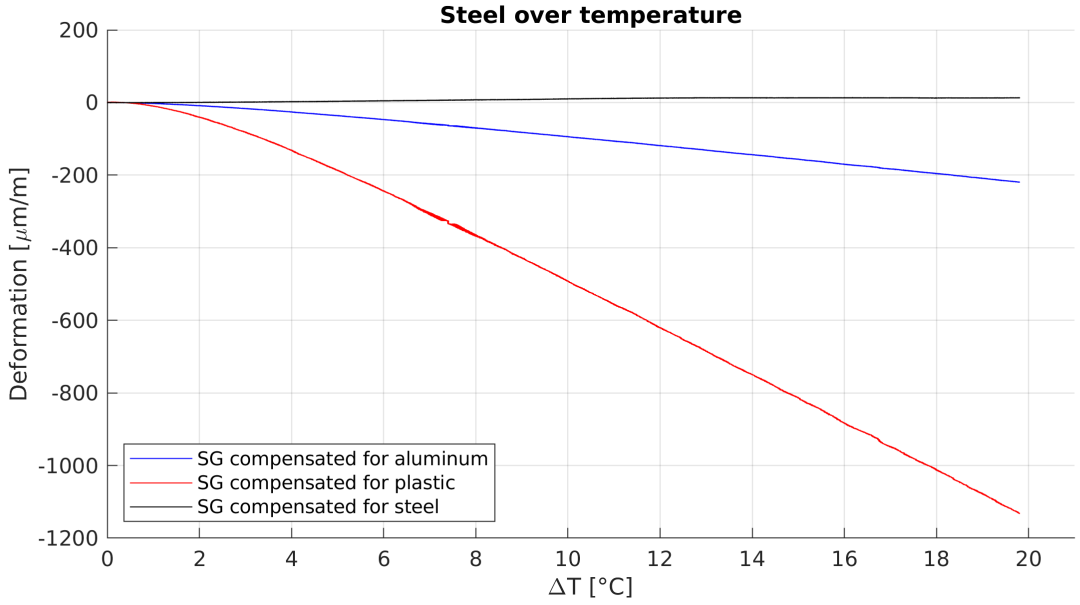


Figure 2: Aluminium sample

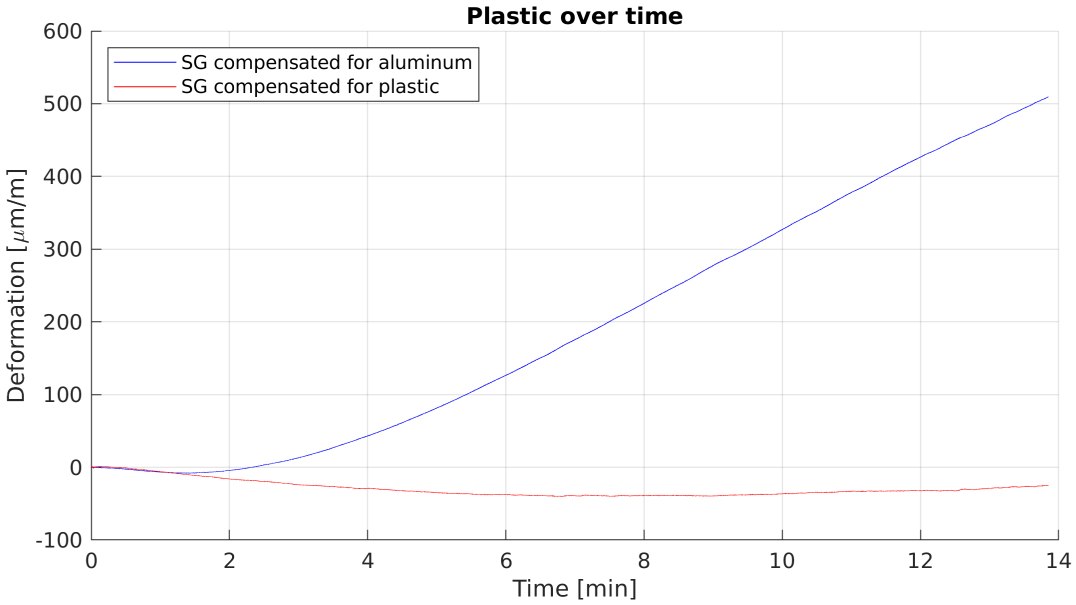


(a) Deformation dependence over time

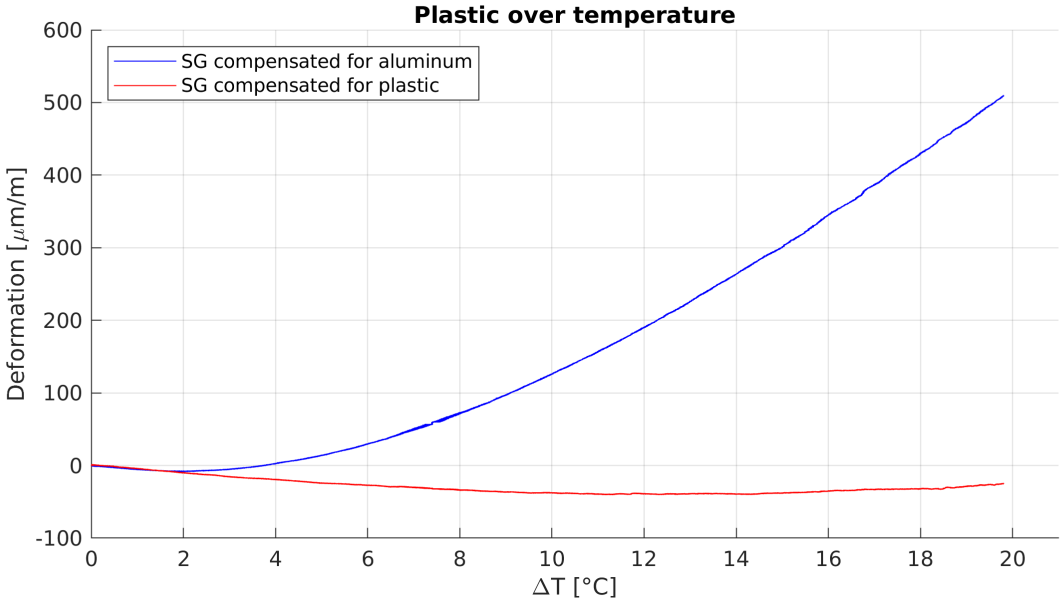


(b) Deformation dependence over temperature difference

Figure 3: *Steel sample*



(a) Deformation dependence over time



(b) Deformation dependence over temperature difference

Figure 4: *Plastic sample*

Conclusion

Just from looking at those figures it's apparent that thermal compensation works for materials it was made for. It's known fact that even compensated strain gauge is not precise when it comes to big temperature changes.

With knowledge gathered during composition of this protocol I have found that it's possible to use non-compensated strain gauge too. When needed to do, it's good idea to place one extra strain gauge to same thermal zone to place, where it's loaded only by deformations caused by heat. Measurer is able to substract the influence of temperature − making his results more accurate.