Experimental Testing for Aerospace Structures

Laboratory Activity n^o 1 — October 24th – 28th, 2022

Name **Surname**

Consider the cantilever beam loaded with a calibrated weight at its free end and equipped with four strain gauges. These are distributed along the beam span both on the upper and lower surfaces, see Fig. 1. The test setup also includes one strain measuring system (properties reported in Fig. 2 and Tab. 1), a digital multi-meter, a thermocouple (to check both the resistance and the operational temperature of the strain gauges), a calibration weight (nameplate accuracy is 1%), a vernier scale, a ruler, and connecting cables. By using the so called *"zero"* and *"deflection"* methods, estimate:

- The strain distribution over the beam span. Also assess the elastic *"linear"* behavior hypothesis
- The Young modulus of the material of the test article and its comparison with properties available in literature

For this purpose:

- evaluate the strain gauge resistances
- evaluate the thermal compensation induced by the current configuration
- statistically characterize the recorded data
- evaluate the uncertainties associated to both the strain and the Young modulus estimates[1]

Write a report, saved in pdf format and named as *"L1_GX_FAMILYNAME.pdf"* detailing the performed analysis and discussing the achieved results.

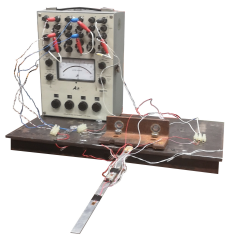

Figura 1: Test setup layout.

[1]The total uncertainty of a derived variable $R = f(x_1, x_2, \cdots, x_n)$, that is function of n direct measures, x_i, $i = 1, 2, \cdots, n$, can be achieved from the uncertainties of all the measures, ε_{x_i}, as

$$\varepsilon_R = \sqrt{\sum_{i=1}^{n} \left(\frac{\partial f}{\partial x_i} \varepsilon_{x_i} \right)^2}$$

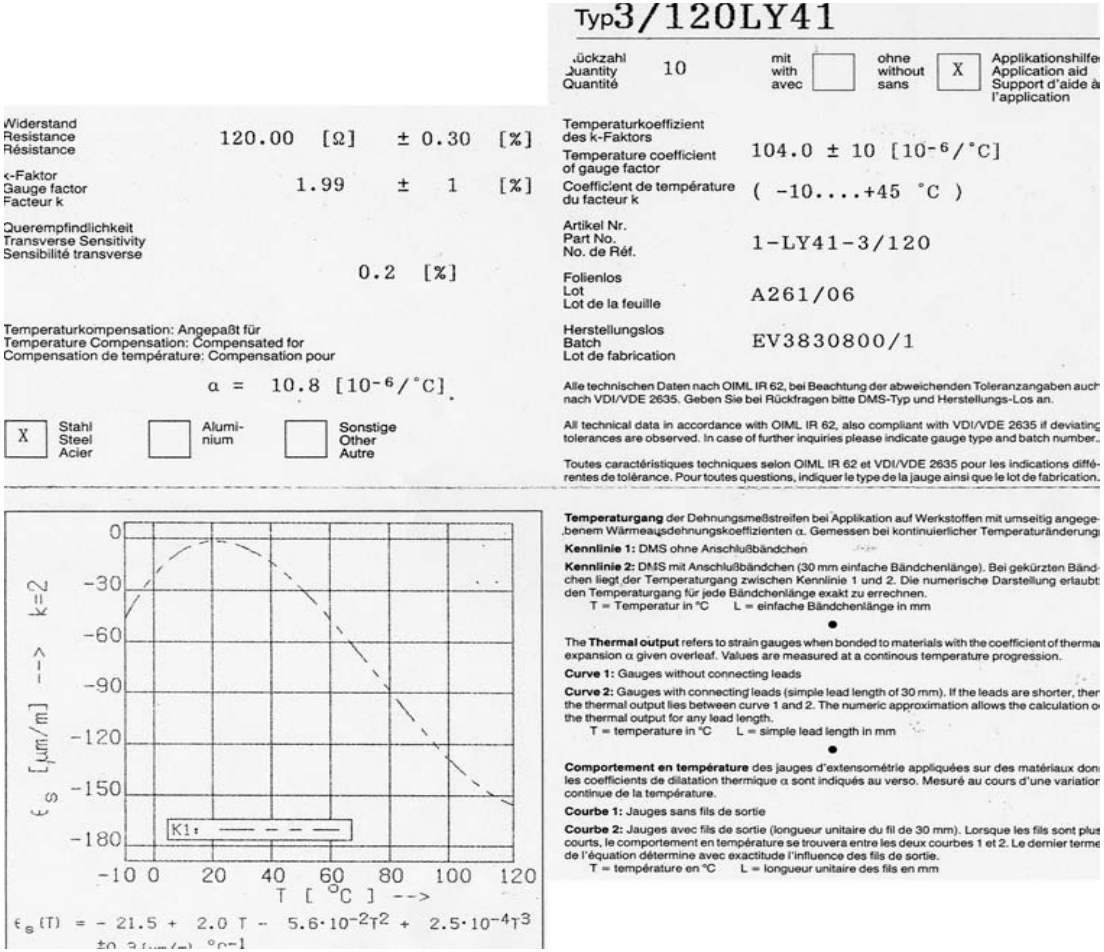

Fig.2 : Strain gauge characteristics

Measuring range	50 000 μs in four dial direct digital display
Compensation bridge	100000 μs
Accuracy	0.05% of measured value ± 0.5 μs (120Ω bridge, gauge factor 2.00, zero method of measurement)
Linearity	0.01% of full range ± 0.5 μs
Repeatability	± 0.2 μs
Stability	0.025 $\mu s/^OC$ (zero method); 0.125%/^OC (deflection method). Temperature range $0 - 40^oC$, full bridge at the input
Input	Five independent input circuits, switch selected. Each input can be used for full, half or 120Ω quarter bridge circuits. Quarter bridge 120Ω also in three-wire system. Input channel one has extra R and C balance controls.
R-C balancing	R ±500μs C ± 1000 pFd
Gauge Resistance	50- 1000 Ω
Gauge Factor	Calibrated from 1.75 to 2.25 in increments of 0.05. Continuously variable 1-10
Bridge Voltage	1.25 and 2.5 V (r.m.s.) Sinewave 1000 Hz
Lead wire capacitance	Typically less than 1 μs additional error for 10 000 pFd on one arm of 120Ω briqge
Null-indicator sensitivity	± 50, ± 200, ± 500, ± 2000, ± 5000 μs sensitivity f.s.d. Accuracy ±1%
Output (for recorder or oscilloscope)	a)± 100 mV DC or peak AC at full scale deflection of null indicator. Remains linear up to 1 Volt (within 2%). Output load > $10O\Omega$. Carrierfrequency suppression is approx 45 db. b)Modulated carrier output 125 mV load > $10k\Omega$
Frequency range for dynamic strain	$0 - 100Hz$ within 1%. $0 - 200Hz$ - 3 dB
Operating temperatures	-10^oC - $+ 60^oC$
Batteries	8 flash-light cells 1.5 V batteries like Berec LPU 2 Witte Kat LP 52
Batterylife	approx. 40 hours
Dimensions	30(h) x 21.5 (w) x 13.5 (d) cm. 11 7/8 x 81/2 x 53/8 inches
Weight	7 kg. 15.4 lbs.

Tab. 1 : Acquisition system characteristics