Akademia Górniczo – Hutnicza Wydział Inżynierii Mechanicznej i Robotyki	
KWMiK	Katedra Wytrzymałości Materiałów i Konstrukcji

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Grade:	Signature:	Date:

STRENGTH OF MATERIALS LABORATORY EXERCISES

Strain Gauge Measurements

Exercise T1

Determination of the sensitivity coefficient "k" of the strain gauge

1. Basic diagram:

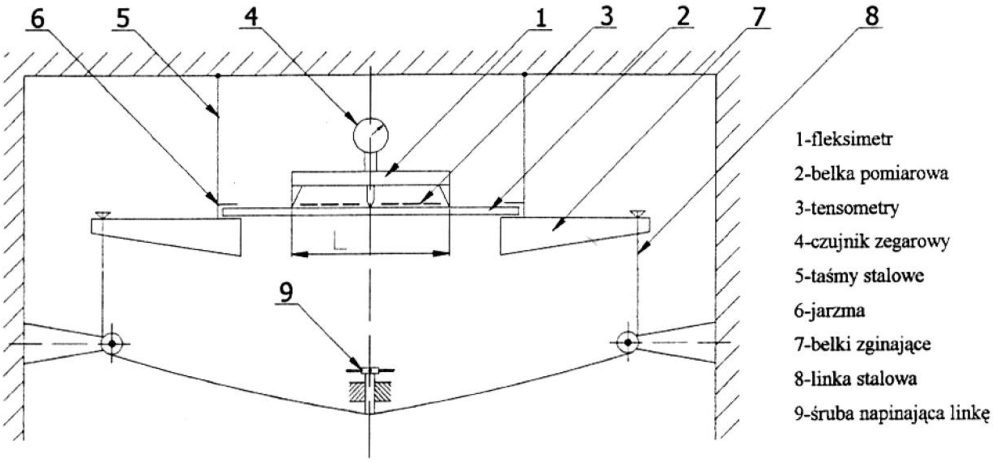

Fig. 1. Construction of an instrument for gauging resistive sensors. 1 – Flexometer; 2 – Beam; 3 – Strain Gauges; 4 – Indicator; 5 – Steel tapes; 6 – Yokes; 7 – Bending Beams; 8 – Steel cable; 9 – Screw for cable tension

2. Formulas

According to the theory of bending beams in the case under consideration, the deflection arrow is:

$$f = \frac{M \cdot L^2}{8EI_X} \text{ [mm]}$$

Stresses in the extreme layers of the beam

$$\sigma = \frac{M}{W_g} = \varepsilon_m \cdot E \text{ [MPa]}$$

Therefore, the relative elongation of the outermost layers can be determined based on the relationship:

$$\varepsilon_m = \frac{4 \cdot f \cdot h}{L^2}$$

Relative elongation of extreme layers determined by means of a bridge circuit MGCplus.

$$\varepsilon_m = \frac{2 \cdot M_P \cdot 10^{-3}}{k}$$

f – Deflection Arrow [mm]
h – Cross-section height [mm]
L – The length of the chord on which the arrow was measured [mm]
M_P – Bridge Circuit MGCplus reading [mV/V]
K – The sensitivity coefficient of the tested resistance strain gauge

Data:

h=5 [mm]
b=50 [mm]
L=200 [mm]
E=$2{,}1 \cdot 10^5$ [Mpa]

3. Measurement Table:

Lp.	*f* [mm]	M_p [mV/V]	*k* [-]	$k_{śr}$ [-]
1	0,1			
2	0,2			
3	0,3			
4	0,4			
5	0,5			
6	0,6			
7	0,7			
8	0,8			
9	0,9			
10	1,0			

4. Calculations

Example of calculation for f = 0.1 [mm] (formula, substitutions, result)

STRENGTH OF MATERIALS LABORATORY EXERCISES

Strain Gauge Measurements

Exercise T2

Determination of longitudinal elastic modulus E

1. **Basic diagram:**

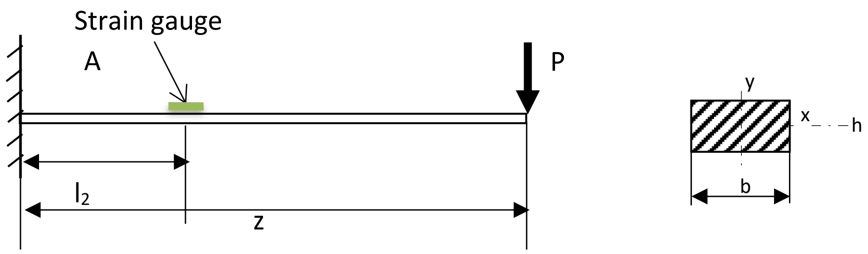

Fig. 1. Diagram of the measuring stand

2. **Formulas**

Stresses in the extreme layers of the beam

$$\sigma = \frac{M}{W_g} = \frac{P(z-l)\cdot 6}{b\cdot h^2}$$

$$W_g = \frac{I_x}{\frac{h}{2}} = \frac{b\cdot h^2}{6}$$

Bending stresses calculated from the Hooke's Law

$$\sigma = \frac{M}{W_g} = \varepsilon_m \cdot E$$

3. **Deformations Measurement**

a) Digital bridge circuit „MGCplus"

$$\varepsilon_{m2} = M_P \cdot 10^{-5}$$

$$E_2 = \frac{P(z-l_2)\cdot 6}{b\cdot h^2\cdot \varepsilon_{m2}}$$

5. Measurement Table:

Table 1

Geometric characteristics (St3, AlZn, Zl, MnCu)					
b [mm]	h [mm]	I_X [mm^4]	W_X [mm^3]	z [mm]	l_2 [mm]

Table 2

Beam Type	Digital bridge circuit „MGCplus”			
	M_p [-]	ε_{m2} [-]	P [N]	E_2 [MPa]
St3				
AlZn				
Zl				
MnCu				