STRENGTH OF MATERIALS – LABORATORY

AGH University of Science and Technology
Chair of Strength, Fatigue
of Material and Construction

Laboratory
Strain gauge measurements

Faculty...
Year...............................*Group*.........................
Date..............................*Mark*..........................
Name...
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Report

1. Internal forces' values calculation basing on strain measurements

A. Basic schemes

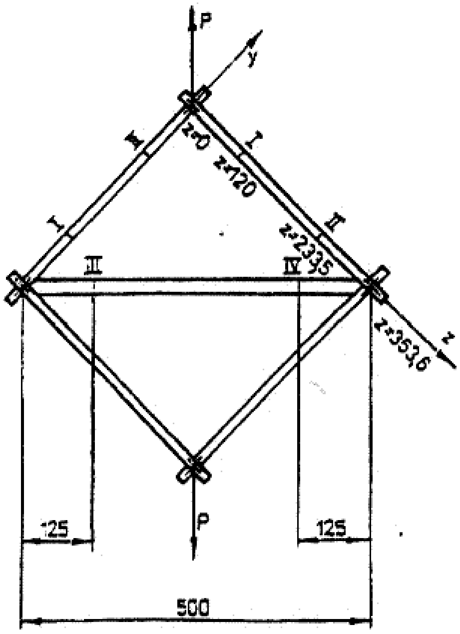

Fig. 1 – Construction scheme and strain gauges localization

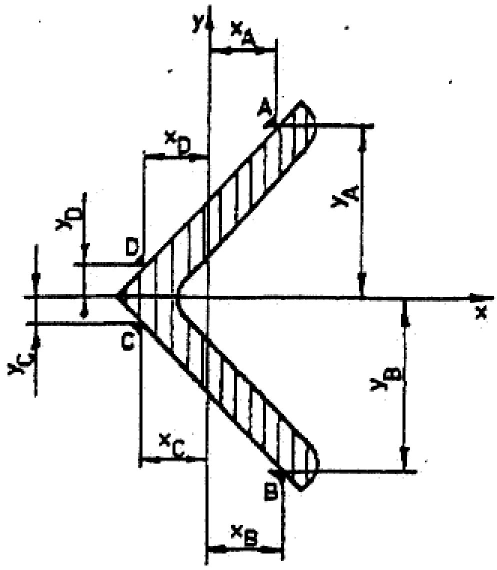

Fig. 2 – Bar cross-section with central principal axes of inertia marked and measurement points localization

B. Basic formulas

$$N = A \cdot \frac{\sigma_A(x_C y_B - x_B y_C) + \sigma_B(x_A y_C - x_C y_A) + \sigma_C(x_B y_A - x_A y_B)}{x_A(y_C - y_B) + x_B(y_A - y_C) + x_C(y_B - y_A)}$$

$$M_x = I_x \cdot \frac{\sigma_A(x_B - x_C) + \sigma_B(x_C - x_A) + \sigma_C(x_A - x_B)}{x_A(y_C - y_B) + x_B(y_A - y_C) + x_C(y_B - y_A)}$$

$$M_y = I_y \cdot \frac{\sigma_A(y_C - y_B) + \sigma_B(y_A - y_C) + \sigma_C(y_B - y_A)}{x_A(y_C - y_B) + x_B(y_A - y_C) + x_C(y_B - y_A)}$$

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Data:

for: L 25 x 25 x 3

$x_A = 0.310\,\text{cm}$ $y_A = 1.340\,\text{cm}$ $I_x = 1.3\,\text{cm}^4$ $k_{rz} = 2.15$

$x_B = -0.610\,\text{cm}$ $y_B = -0.420\,\text{cm}$ $I_y = 0.33\,\text{cm}^4$ $E = 210\,\text{GPa}$

$x_C = 0.310\,\text{cm}$ $y_C = -1.340\,\text{cm}$ $A = 1.45\,\text{cm}^2$

$x_D = -0.610\,\text{cm}$ $y_D = 0.420\,\text{cm}$ $k_0 = 2.0$

for: L 30 x 30 x 4

$x_A = 0.310\,\text{cm}$ $y_A = 1.340\,\text{cm}$ $I_x = 2.9\,\text{cm}^4$ $k_{rz} = 2.15$

$x_B = -0.610\,\text{cm}$ $y_B = -0.420\,\text{cm}$ $I_y = 0.75\,\text{cm}^4$ $E = 210\,\text{GPa}$

$x_C = 0.310\,\text{cm}$ $y_C = -1.340\,\text{cm}$ $A = 2.27\,\text{cm}^2$

$x_D = -0.610\,\text{cm}$ $y_D = 0.420\,\text{cm}$ $k_0 = 2.0$

σ_P - value of normal stress at point *P = A, B, C*

x_P, y_P - coordinates of point *P = A, B, C* in coordinate system of principal central axes of inertia

A, I_x, I_y - area of cross-section, moments of inertia of cross-section

C. Measurement chart

Measurement number	Loading force [N]	Point	Stress σ [MPa]	Axial force N [N]	Bending moment M_x [Nm]	Bending moment M_y [Nm]	Resultant moment M_w [Nm]
1		I A					
2		I B					
3		I C					
4		I D					
5		II A					
6		II B					
7		II C					
8		II D					

All calculations should be attached to the report.

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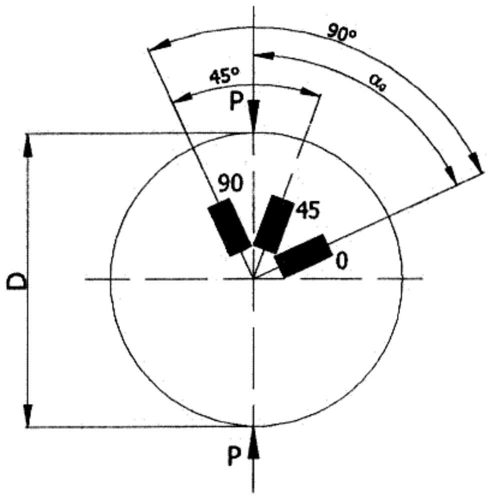
2. Principal stresses and directions of principal stresses determination

A. Basic schemes and formulas:



$$\sigma_{max/min}=\frac{E}{2}\left[\frac{\varepsilon_0+\varepsilon_{90}}{1-\nu}\pm\frac{1}{1+\nu}\sqrt{(\varepsilon_0-\varepsilon_{90})^2+(2\varepsilon_{45}-\varepsilon_0-\varepsilon_{90})^2}\right]$$

$$\mathrm{tg}\,2\alpha=\frac{2\varepsilon_{45}-(\varepsilon_0+\varepsilon_{90})}{\varepsilon_0-\varepsilon_{90}}$$

$$\tau_{max}=\frac{\sigma_{max}-\sigma_{min}}{2}$$

Data:

$E=210\,\mathrm{GPa}$ $\varphi=0^\circ$

$\nu=0.3$ $\beta=45^\circ$

$k=$ $\gamma=90^\circ$

ε_0 -longitudinal strain along direction $\varphi=0^\circ$

ε_{45} -longitudinal strain along direction $\beta=45^\circ$

ε_{90} -longitudinal strain along direction $\gamma=90^\circ$

$$\varepsilon=(M_p-M_o)\frac{2.0}{k_{rz}}\cdot 10^{-3}$$

	φ direction			β direction			γ direction			σ_1	σ_2	τ_{max}	α
	M_o	M_p	ε_0	M_o	M_p	ε_{45}	M_o	M_p	ε_{90}				
	‰	‰	-	‰	‰	-	‰	‰	-	[MPa]	[MPa]	[MPa]	-
1													
2													

All calculations should be attached to the report

Draw Mohr's stress circle and determine components of the stress state for angle α