AGH University of Science and Technology
Kraków
Department of Strength & Fatigue of Material & Structures

Laboratory exercises

PHOTOELASTIC ANALYSES

Faculty: ……………...………………………

Year of study ………… Group No ………

Date of exercise ………… Mark:…………

Names: ………………………………………

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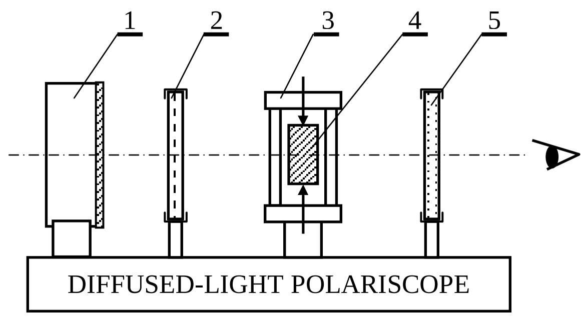
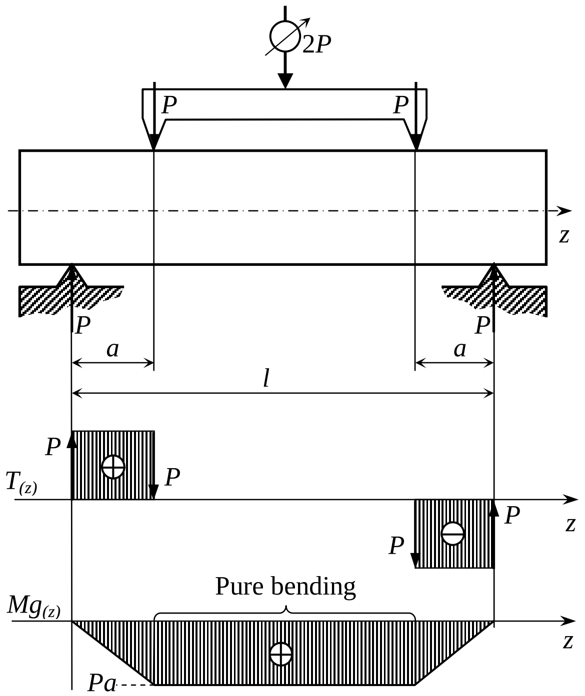
<u>Task No. 1.A:</u> **Determination of the constant of the photoelastic model based on isochromatic fringe pattern observed on a beam loaded by pure bending.**

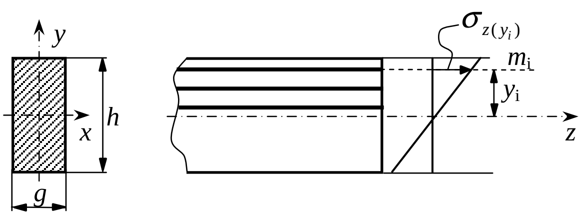
1) The test stand diagram:



1 – source of light
2 – polarizer
3 – load frame
4 – tested specimen
5 – analyzer

2) The loading diagram:





<u>Basic relationships:</u>

$$\sigma_{z(y_i)} = m_i \cdot K \qquad \text{(A1)}$$

$$\sigma_{z(y_i)} = \frac{Mg_{(z)}}{J_x} \cdot y_i = \frac{12 \cdot Pa}{g \cdot h^3} \cdot y_i \qquad \text{(A2)}$$

From eq. (1) & (2):

$$K = \frac{12Pa}{g \cdot h^3} \cdot \frac{y_i}{m_i} \qquad \text{(A3)}$$

where:

y_i – coordinate of the m_i order isochromatic fringe

K – constant of the photoelastic model

3) Dimensions of the specimen:

h =.............. mm *g* =.............. mm *l* =.............. mm *a* =.............. mm

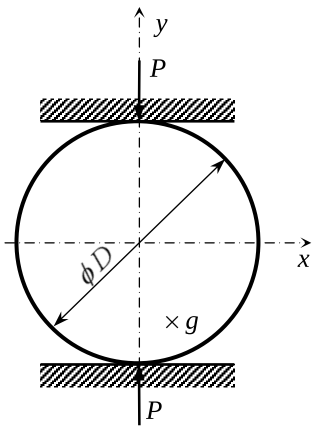
Force gage factor: *k* =.............. N/scale,

4) Experimental and calculation results:

Load level		**Isochromatic fringe order m_i**	**Coordinate of m_i – order isochromatic fringe**	**Constant of the photoelastic model**
2*P*, (scale)	**2*P*, (N)**		**y_i, (mm)**	***K*, (MPa)**
			K_{av}=	

Task No. 1.B: Determination of constant of the photoelastic model based on isochromatic fringe pattern observed on a compressed circular disc.

1) The loading diagram:



2) Basic relationships:

a) Stresses in the center of disc:

$$\sigma_x = \frac{2P}{\pi g D}; \qquad \sigma_y = -\frac{6P}{\pi g D}; \tag{B1}$$

$$\sigma_1 - \sigma_2 = \sigma_x - \sigma_y = \frac{8P}{\pi g D}; \tag{B2}$$

b) Stress-optic law:

$$\sigma_1 - \sigma_2 = m \cdot K; \tag{B3}$$

c) Model stress-optical coefficient for the circular disc (compare to eq. B2 – B3):

$$K = \frac{8P}{\pi g D m}; \tag{B4}$$

where:
D, *g* – disk dimensions (see on the figure)
m –isochromatic fringe order in the center of the disc

3) Dimensions of the disc:

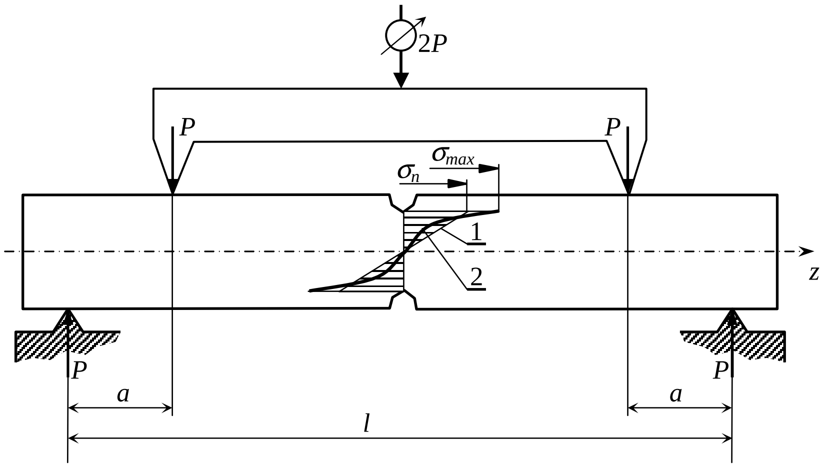
D =.............. mm *g* =.............. mm

4) Experimental and calculation results:

Load level		**Isochromatic fringe order in the center of disc m_i**	**constant of the photoelastic model**
***P*, (scale)**	***P*, (N)**		***K*, (MPa)**
		K_{av}=	

<u>Task No. 2:</u> Determination of the stress concentration factor (k_t) for the loaded by pure bending beam with single and double notch.

1) The loading diagram:

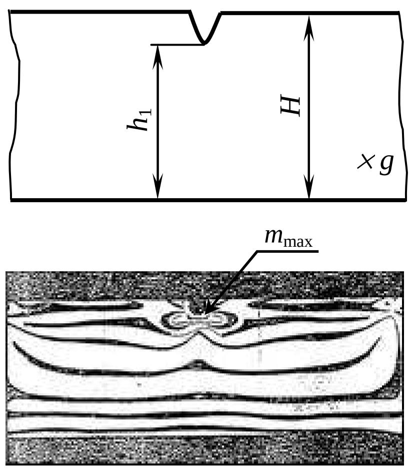


1 – distribution of the nominal stress

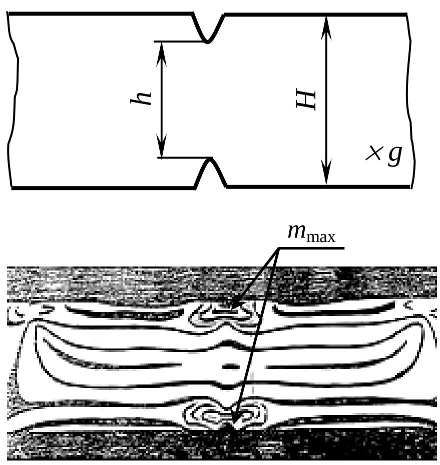
2 – distribution of the real stress

2) Considered specimens:

a) Model I
The single-notch beam:



b) Model II
The double-notch beam:



3) <u>Basic relationships:</u>

a) Stress concentration factor k_t (definition):

$$k_t = \frac{\sigma_{max}}{\sigma_n}; \qquad (2.1)$$

b) Maximum stresses at the notch tip σ_{max}:

$$\sigma_{max} = K \cdot m_{max}; \qquad (2.2)$$

where: m_{max} – maximum isochromatic fringe order observed at the notch tip
K – constant of the photoelastic model – assume K=K_{av} (acc. to Task No. 1.A)

c) Nominal stresses σ_n:

Model I:

$$\sigma_n = \frac{M_g}{W_{g\,netto}} = \frac{6Pa}{gh_1^2}; \qquad (2.3a)$$

Model II:

$$\sigma_n = \frac{M_g}{W_{g\,netto}} = \frac{6Pa}{gh^2}; \qquad (2.3b)$$

4) Specimens' dimensions:

l =................ mm *a* =.............. mm *H* =.............. mm *g* =.............. mm

h_1 =.............. mm *h* =.............. mm

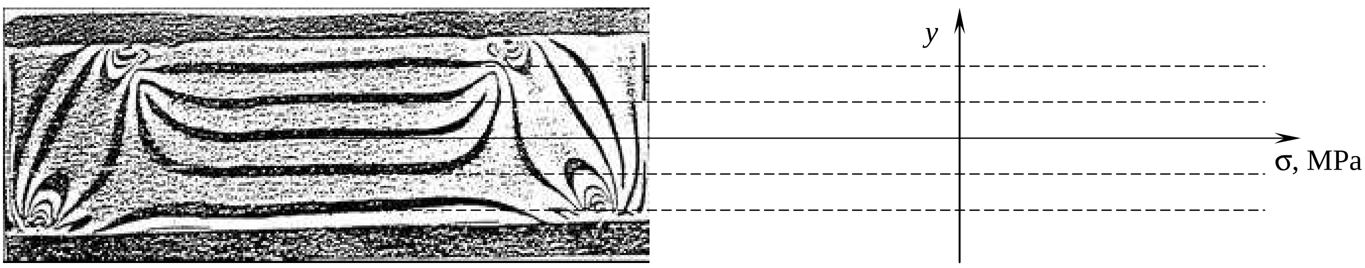
5) Experimental and calculation results:

Specimen:	Load level		Isochromatic fringe order at the notch tip - m_{max}	Stress concentration factor - k_t
	2*P*, (scale)	2*P*, (N)		
Model I				
Model II				

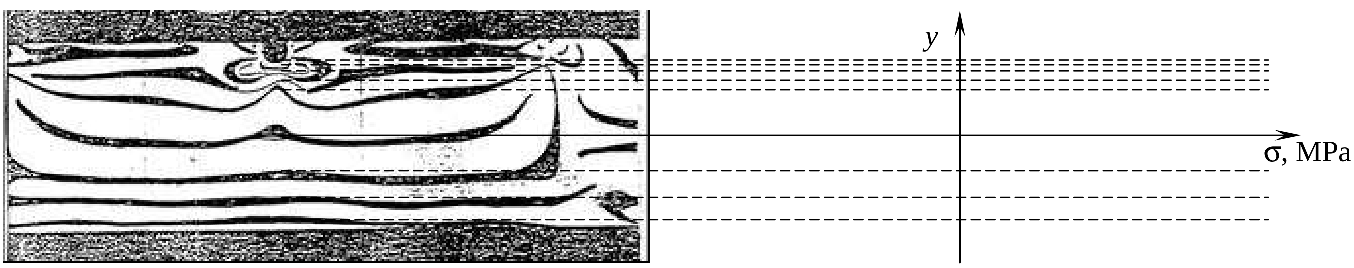
6) Stress distributions in the loaded by pure bending beam determined based isochromatic pattern fingers:

K_{av} =................ MPa (acc. to Task No. 1.A)

a) The smooth beam:



b) The single notch beam:



c) The double notch beam: