LAB 4: Modulus of elasticity

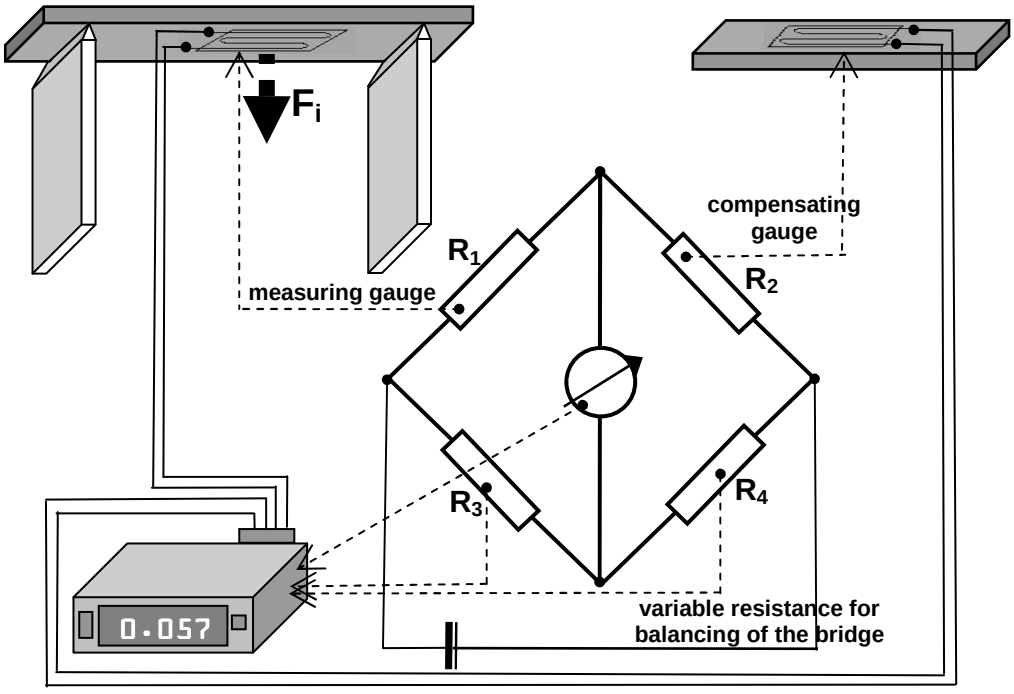
1. Preparation:

- modulus of elasticity (chapter15, p.79)
- Hook's law
- graphical determination of modulus of elasticity (p.80)
- determination of modulus of elasticity in tension and flexural stress
- mechanical strain gauges, electrical resistant gauges
- basic strain at basic loading ((chapter 15.2.3, p.84)

2. Procedure

The students will be divided into 3 groups, each will measure the modulus of elasticity in the flexural stress of the different materials The strain will be measured by the electrical resistance gauge with the help of apparatus TSA. The principal of the measuring is described in the chapter 15.2.2.

Scheme of measuring:



Measuring:

Material will be loaded gradually and after each loading step the load goes back to the basic load F_0. Scheme of the loading will be given at the lesson.

1. Switch on the apparatus
2. Zero the apparatus by the button 0
3. Apply load F_1 on the material.

4. After the stabilization read the value of deformation in promiles from the display and write it into the table as a **1st set of reading** at the load F_1 [‰].
5. Unload to the load F_0 and write the value on the display as a 1st set at the load F_0 [‰].
6. Repeat the procedure from points 3 to 5 for the loading F_2 and F_3.
7. After each loading to F_i there is necessary to unload to F_0 and write down the value of the deformation
8. During the one loading set the material shouldn't be fully unloaded.
9. After one complete loading set switch off the apparatus.
10. Measure the cross-sectional dimensions ***b, h*** [mm] at the place of measuring (*be careful not to touch glued gauge!),* each dimension minimally twice.
11. Measure the distance between supports ***l*** [mm]
12. Repeat the measuring according points 1 to 9 and the results write down as a **2nd set of reading**

3. Protocol

Modulus of elasticity in flexural stress (*form LAB 4:a) Modulus of elasticity in flexural stress)*

- determine relative elastic deformations (elastic strain) ε_i [‰] as a differences between readings at loading stages F_i and subsequent reading at basic load F_0 for both sets and count their mean value ε_i' [‰]
- count the basic strain ε_0 [‰] between zero and basic loading F_0 from similarity of triangles (Fig. 44 – p.84) and count the total strain $(\varepsilon_i' + \varepsilon_0)$ [‰] for each loading step
- count the strain σ_i [MPa] at each loading step according the type of loading flexural stress, tension)
- count the modulus of elasticity E_i [MPa] from Hook's law
- count mean value of the modulus of elasticity ***E*** [MPa] from all loading stages

Modulus of elasticity in tension (*form LAB 4:a) Modulus of elasticity in flexural stress)*

- the data, measured on the steel, will be given
- the mechanical gauges (Fig. 40 – p. 81) were used for measuring
- determine the real deformation Δl [mm] as a differences between readings at loading stages F_i and at basic load F_0
- count the relative strains (relative deformations) ε_i [‰] from the real deformations and the original gauge length (l_{01}, l_{02})
- the rest of the determination is the same as a determination of modulus of elasticity in flexural stress

For protocol you can use the form attached. If you use the hand made form, it has to be similar to this form.

LAB 4: Modulus of elasticity

Name:	**PIN:**
Signature:	Study group:
Date:	Number of annexes : (all calculations, given data)

Results:		
Tested material :		
Modulus of elasticity in flexural stress	MPa	
Steel		
Modulus of elasticity in tension	GPa	

LAB 4: a) MODULUS OF ELASTICITY IN FLEXURAL STRESS

Material :

Source of loading :

Measuring apparatus :

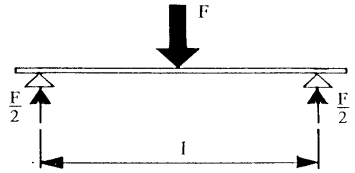
Cross sectional size:
[mm]

Section modulus :
[mm^3]

Basic strain (between 0 and F_0):

$$\varepsilon_0 = \varepsilon_1' \cdot \frac{F_0}{F_1 - F_0} =$$

Loading scheme :



l = [mm]

$$M_i = \frac{F_i * l}{4}$$

Loading F_i	**Reading of apparatus**		**Relative strain during unloading from F_i to F_0**			**Total strain** ($\varepsilon_i' + \varepsilon_0$)	**Bending moment** M_i	**Stress** $\sigma_i = \frac{M_i}{W}$	**Modulus of elasticity** $E = \frac{\sigma_i}{(\varepsilon_i' + \varepsilon_0) * 10^{-3}}$
	1st set	2nd set	1.	2.	Mean.ε_i'				
[N]	[‰]		[‰]			[‰]	[N. mm]	[MPa]	[MPa]
F_1 =									
F_0 =									
F_2 =									
F_0 =									
F_3 =									
F_0 =									
								Mean value of the modulus of elasticity:	

LAB 4: b) MODULUS OF ELASTICITY IN TENSION

Material :
STEEL

Source of loading:
Press FP 100

Measuring apparatus:
2 mechanical strain gauges

Diameter:
[mm]
d1 = d2= mean d =

Cross sectional area:
[mm^2] A =

Basic strain (between 0 and F_{t0})**:**

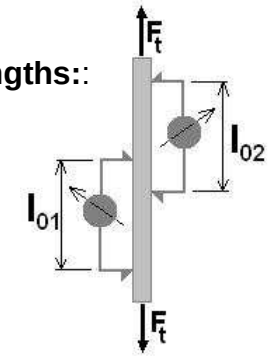
$$\varepsilon_0 = \varepsilon_1' \cdot \frac{F_{t0}}{F_{t1} - F_{t0}} =$$

Loading scheme :

original gauge lengths::
[mm]

l_{01}=

l_{02}=



Loading F_{ti}	**Reading of the gauges**		**Strain during unloading from F_{ti} to F_{t0}**					**Total strain** $(\varepsilon_i' + \varepsilon_0)$	**Stress** $\sigma_i = \frac{F_{ti}}{A}$	**Modulus of elasticity** $E_i = \frac{\sigma_i}{(\varepsilon_i' + \varepsilon_0)}$
			real Δl		**relative** $\varepsilon_i = \frac{\Delta l_i}{l_{0i}}$					
	1st gauge	2nd gauge	1.	2.	1.	2.	mean ε_i'			
[N]	[mm]		[mm]		[-]			[-]	[MPa]	[MPa]
F_{t1} =										
F_{t0} =										
F_{t2} =										
F_{t0} =										
F_{t3} =										
F_{t0} =										

Mean value of the modulus of elasticity of steel: