LABORATORY WORK No. 1

METHODS FOR STATICAL TESTING OF MATERIALS

Student:	……..... ……..... …….....		
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SUBJECT OF THE LABORATORY WORK

Introduction to the methods for determination of the mechanical characteristics of materials subjected to tensile, compressive and shearing loading.

The laboratory work consists of four parts:
Part 1. Tensile test of low-carbon steal.
Part 2. Determination of the modulus of elasticity E and Poisson's ratio ν of 40X steel.
Part 3. Compressive test of aluminum alloy.
Part 4. Shearing testing of low-carbon steel.

1. TENSILE TEST OF LOW-CARBON STEAL

1.1. TASKS:

1) Determination of the yield strength σ_y ;

2) Determination of the ultimate strength σ_u ;

3) Determination of the rapture stress σ_B ;

4) Calculation of the reduction in area coefficient in percent Z.

1.2. EQUIPMENT:
Universal testing machine ZD 20, calipers, standard tensile-test specimen.

1.3. EXPERIMENTAL SCHEME:
The principle scheme is shown on fig. 1.

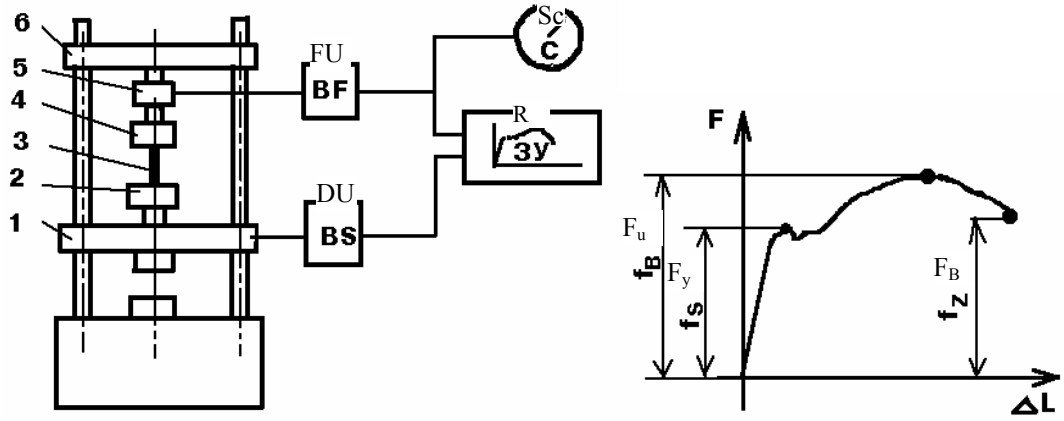

Fig. 1

1 - movable crossarm; 2 - movable handle; 3 - specimen; 4 - unmovable handle; 6 - unmovable crossarm; DU - deformation measuring unit; FU - force measuring unit; Sc - scale; R - recording unit.

1.4. BASE DATA:
1. Tensile-test specimen's diameter d_0=……mm.

2. Material type: low-carbon steel St5

1.5. RESULTS:

1. Ultimate force $F_u = ...N.$

2. The distances f_y, f_u and f_B (fig.2) are measured and input in *Table 1*;

3. Minimum diameter of the specimen $d_{min} = ...mm.$

Table 1

f_y mm	f_u mm	f_B mm	F_y kN	F_u kN	F_B kN	σ_y MPa	σ_u MPa	σ_B MPa

1.6. PROCESSING THE RESULTS

1. Determination of the force scale factor $K_F = \frac{F_u}{f_u} = ...N/mm.$

2. Calculation of the values of the forces:

$F_B = K_F f_B = ...N.$ $F_y = K_F f_y = ...N.$

3. Determination of the cross sectional area

$$A = \frac{\pi d_0^2}{4} = ...m^2$$

4. Calculation of the stresses:

$\sigma_y = \frac{F_y}{A} = ...MPa$ – Yield stress

$\sigma_u = \frac{F_u}{A} = ...MPa$ – Ultimate stress

$\sigma_B = \frac{F_B}{A} = ...MPa$ – Rapture stress

5. Write down the received values of the stresses in *Table 1.*

6. Calculation the reduction in area coefficient $Z = \frac{d_0 - d_{min}}{d_0} 100 = ...\%.$

1.7. CONCLUSIONS:

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2. DETERMINATION THE MODULUS OF ELASTICITY E AND POISSON'S RATIO ν OF 40X STEEL.

2.1. TASKS:

1) Determination of the modulus of elasticity E.
2) Determination of the Poisson's ratio ν.

2.2. EQUIPMENT:

Universal testing machine ZD20, calipers, specimen, strain measuring amplifier, strain gages.

2.3. DESCRIPTION OF THE EXPERIMENT .

The specimen is fitted in the handles of the machine 2 and 4. Four strain gages are glued on the specimen. Two of them are along its axis and two are perpendicular to it. Two strain-gages are glued on an undeformed body. They are known as thermo-

compensative gages. Two independent half-bridge schemes are formed. The first one measures the longitudinal elongation – axial strain **ε** and the second one measures the transverse strain $\overline{\varepsilon}$. Two channels of the strain –measuring amplifier give respectively the signals for axial and transverse strains.

2.4. BASE DATA:
Diameter of the specimen d=……..mm

2.5. RESULTS
The specimen is loaded in tension statically till 30 kN with a step of 10 kN. Read the values of the strains **ε** and $\overline{\varepsilon}$ and input them in *Table 2*.

2.6. PROCESSING THE RESULTS

1. Determination of the cross-sectional area of the specimen $A = \frac{\pi d^2}{4} = ...m^2$

2. Calculation of the stresses for the different values of the load $\sigma_i = \frac{F_i}{A},[Pa]$

3. Determination of the modulus of elasticity for the values of the strain ε_i $E_i = \frac{\sigma_i}{\varepsilon_i},[Pa].$

4. Determination of the Poisson's coefficient ν $\nu = \frac{|\overline{\varepsilon}_i|}{\varepsilon_i}$

5. Write down the values in *Table.2*.

Table 2

F_i [N]	$\varepsilon_i .10^{-6}$	$\overline{\varepsilon}_i .10^{-6}$	σ_i	E_i	ν_i
10 000					
20 000					
30 000					

6. Determination of the mean arithmetical value of the modulus of elasticity E and Poisson's coefficient

$$E = \frac{\sum E_i}{3} = ... \text{ [Pa]}; \qquad \nu = \frac{\sum \nu_i}{3} = ...$$

2.7. CONCLUSIONS:
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3. COMPRESSION TEST

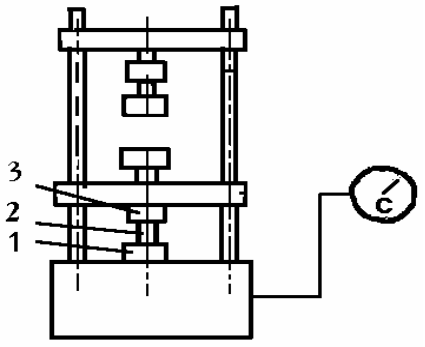

Fig.2

3.1. TASKS
Determination of the fracture stress of aluminum alloy subjected to pure compression.

3.2. EQUIPMENT
Universal testing machine ZD20, calipers, specimen
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3.3. DESCRIPTION OF THE EXPERIMENT:
The specimen 2 is placed between plates 1 and 3 and is loaded till fracturing. The maximum force is read from the scale C.

3.4. BASE DATA
Diameters of the specimen

D = ...mm = ...m. d = ...mm = ...m.

3.5. RESULTS
Maximum force F_u = ...N.

3.6. PROCESSING THE RESULTS

1. Determination of the cross-sectional area of the specimen $A_0 = \frac{\pi}{4}\left(D^2 - d^2\right) = ...m^2.$

2. Calculation of the fracture stress $\sigma_u = \frac{F_u}{A_0} = ...MPa.$

3.7. CONCLUSIONS:

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4. SHEARING TEST

4.1. TASKS:
Determination of the rapture shearing stress of low-carbon steal.

4.2. EQUIPMENT
Universal testing machine ZD20, specimen, shearing device.

4.3. DESCRIPTION OF THE EXPERIMENT
The force F is applied to the knives 2, 3 and 4 and they cut the specimen into three parts.

4.4. BASE DATA
Diameter of the specimen d=……mm=……m

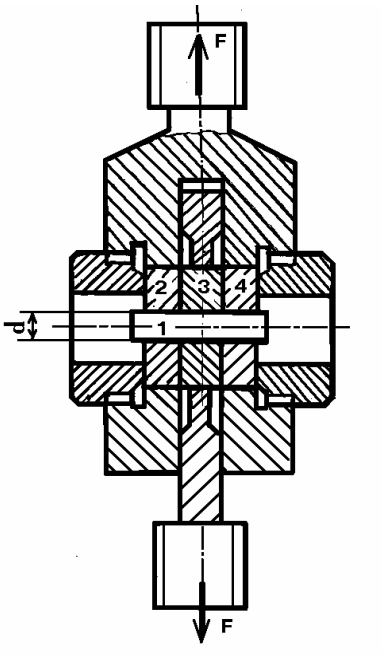

Fig. 3

4.5. RESULTS
Maximum shearing force F_u=……..N

4.6. PROCESSING THE RESULTS
1. Determination of the cross-sectional area of the specimen

$A = \frac{\pi}{4}d^2 = ...m^2$

2. Calculation of the fracture shearing stress $\tau_u = \frac{F_u}{2A} = ...Pa$

4.7. CONCLUSIONS:
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