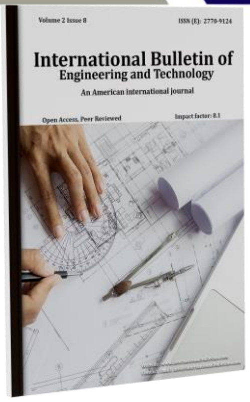

CHECKING THE STRESS STATE OF VARIOUS MATERIALS.

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Allowable stresses corresponding to various strength theories in the science of materials resistance can be determined using the WR-130 testing equipment. This theoretical and incomprehensible part of the resistance of materials to the researcher becomes understandable through experience.

Allowable stresses are used to find the stress produced by the combined normal and tensile forces in a material. Because the properties of the material can be determined only in the case of uniaxial stress (tensile strength limit, yield strength), it is necessary to determine the corresponding allowable stresses in the case of bi- or triaxial stress.

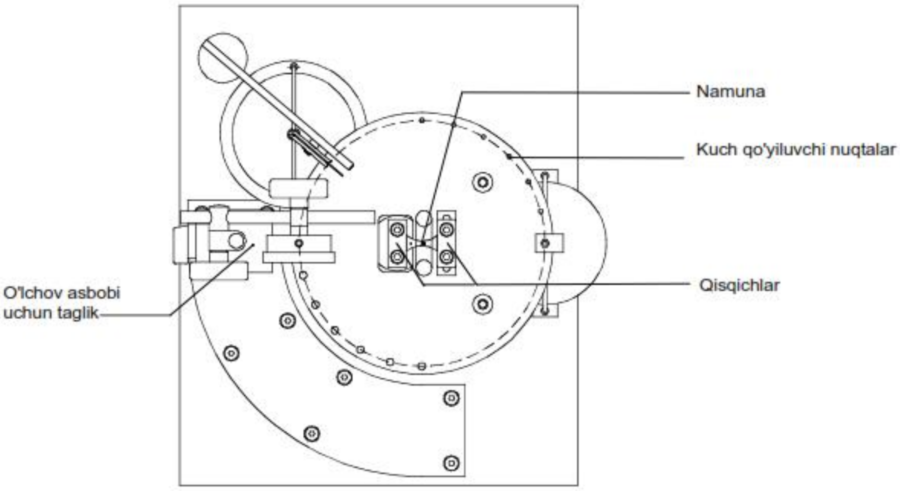
Normal and test stresses should be considered at exactly one point of the specimen to prove the criterion of allowable stresses. Tensile forces do not affect this place, because they reach their maximum value in the middle section. In this test equipment, the stress-strain state of the specimen consists of bending and twisting. They are carried out using simple mechanical means. The test equipment can be tested in pure bending or pure torsion or their combination on the sample.

The WR 130 test rig looks great and works perfectly. Simple-looking samples are used.

One end of the sample is fixed to a fixed frame and the other end to a circular plate. The load can be placed on the edge of the circular plate at any desired angle.

This creates the desired multiaxial stress state in the specimen.

The deformation of the sample is visible on the measuring instrument. The researcher learns what mechanical tools to use and how to conduct tests to measure strain.



Deformation is measured at a point diametrically opposite to the point where the force is applied. This allows the deformation to be measured at the point where it reaches its maximum value. In this case, the error is minimized by measuring the deformation in the unstressed part of the plate.

The cross-section of the sample is circular, and it is fixed using friction clamps.

The sample is compensated for the specific weight of the plate and the weight of the load so that it is not affected by the transverse forces caused by them. In order to ensure static accuracy and avoid prestressing the clamps, the force plate is connected to the post by a flexible thread.

Technical information

Dimensions: length-390mm, width-325mm, height-325mm, weight-17kg.

Power equipment: Power moments-0...30Nm, Split weight-0.1 Nm.

Direction: Between pure bending and pure torsion.

Force shoulder-100mm, loads-1 N, 2 N, 4 N, 8 N, maximum load-30N.

Sample material: Steel S 235 JR, Copper Cu-ETP, Brass CuZn39Pb3,
Aluminum AlMgSi 0.5 F22.

Deformation measurement using a measuring instrument.

Measuring range-0...10mm, division interval-0.01mm

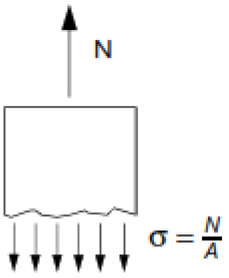
Theoretical data Permissible voltage

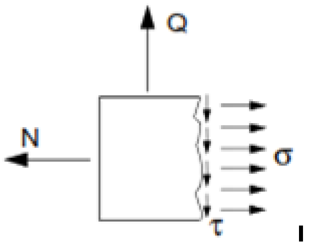
It is necessary to determine the state of uniaxial stress, i.e., the yield stress in pure tension or compression. This corresponds to tensile or compressive stress. The ultimate stress can be easily determined in tension or compression.

A multiaxial stress state in which normal and tensile stresses occur is caused by normal and transverse or bending forces. Such a combination of stresses can lead to a breakdown.

The strength of the material can be determined only in the case of uniaxial stress, i.e. in the tensile test. A similar allowable stress can be determined in the case of multiaxial stress.

Different theories of strength have been proposed at different times and their corresponding allowable stresses have been determined. The main three of them are as follows.





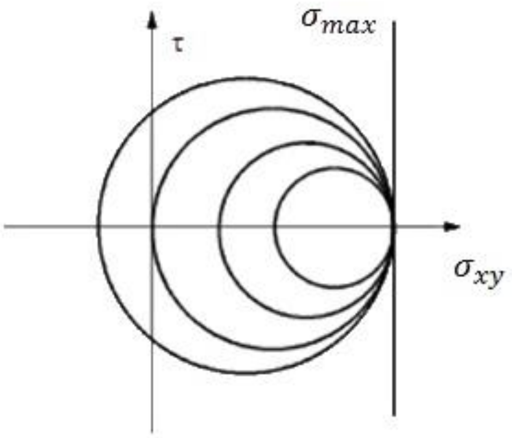
uniaxial stress state **multiaxial stress state**

Criterion of maximum head voltage
(RANKIN).

Accordingly, the material is absorbed under the influence of the greatest normal stress. This term is used in brittle fracture. The plane of rupture is perpendicular to the direction of force.

Experiments show that this criterion works well for brittle materials, for example, cast iron.

$$\sigma_{min}^{max} = \frac{1}{2}\left[\left\{\sigma_x + \sigma_y\right\} + \frac{1}{2}\sqrt{\left(\sigma_x + \sigma_y\right)^2 + 4{\tau_{xy}}^2}\right]$$



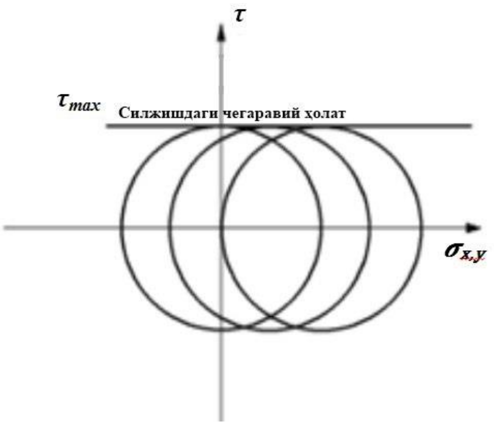
**Maximum test voltage criterion
(MOR).**

According to it, failure occurs when the tensile stress reaches the maximum value in the material. a shear crack occurs. The greatest tensile stress occurs at an angle of 45° to the direction of the greatest principal stress, the crack plane occurs at 45° to the direction of the principal force.

This criterion is mainly suitable for strong, plastic materials such as copper, mild steel and aluminum.

$$\sigma_v = 2\tau_{max} = \sqrt{\left(\sigma_y - \sigma_x\right)^2 + 4\tau^2}$$

$$\sigma_{экв} = \sqrt{(\sigma_z)^2 + 3\tau^2} \leq [\sigma]$$



Criterion of the maximum shear deformation energy
(MISES and GENKA).

According to this criterion, when the elastic energy exceeds a certain value, the material is destroyed. If a force is applied to the body, it is deformed. For this deformation to occur, the external force must do work equal to the elastic energy. Deformation can be a change in volume and a change in shape.

According to the criterion of elastic energy, collapse occurs when the shape change deformation is too large. This criterion is relevant for bodies under the influence of dynamic and variable forces, regardless of the type of material.

Рухсат этилган кучланишлар бош кучланишлар ва уринма кучланишлар орқали is expressed. The relationship between these two voltages can be represented graphically using Mohr's circle. In this case, the test stress is represented by the normal stress.

In pure bending, the stress circle is located to the right of the coordinate axis. The test voltage is zero in the direction of the second principal voltage.

In pure torsion, both principal stresses are zero. The center of the tension circle is located at the coordinate origin.

When bending and torsion are present, the mixed stress range lies between the ranges of the two pure stress states.

A combination of bending and twisting forces.

Below is the relationship between the allowable stress in bending and torsion and the external force. A single material is used as a sample and the shear deformation criterion is appropriate.

$$\sigma_{\text{экв}} = \sqrt{(\sigma_z)^2 + 4\tau_{zy}^2} \leq [\sigma]$$

$$\sigma_v = 2\tau_{max} = \sqrt{\left(\sigma_y - \sigma_x\right)^2 + 4\tau^2}$$

In the case of bending forces, there are no normal stresses in the direction perpendicular to the axis of the specimen. In this $\sigma_y = 0$ and

$$\sigma_v = 2\tau_{max} = \sqrt{\sigma_x^2 + 4\tau^2}$$

The maximum normal stress at the end of the specimen is expressed by the bending moment and the geometric moment of inertia as follows.

$$\sigma_x = \frac{M_b}{l_b}\frac{d}{2}$$

The maximum tensile stress occurs at the end of the specimen.

$$\tau = \frac{M_t}{l_t}\frac{d}{2}$$

Geometric moments of inertia for a circular cross section

$I_b = \frac{d^4\pi}{64}, \qquad I_t = \frac{d^4\pi}{32}$

The external bending moment Mb is expressed by the twisting moment Mt angle and the force F as follows.

$$M_b = Frcos\varphi, M_t = Frsin\varphi$$

If we consider the expressions of bending and twisting moments

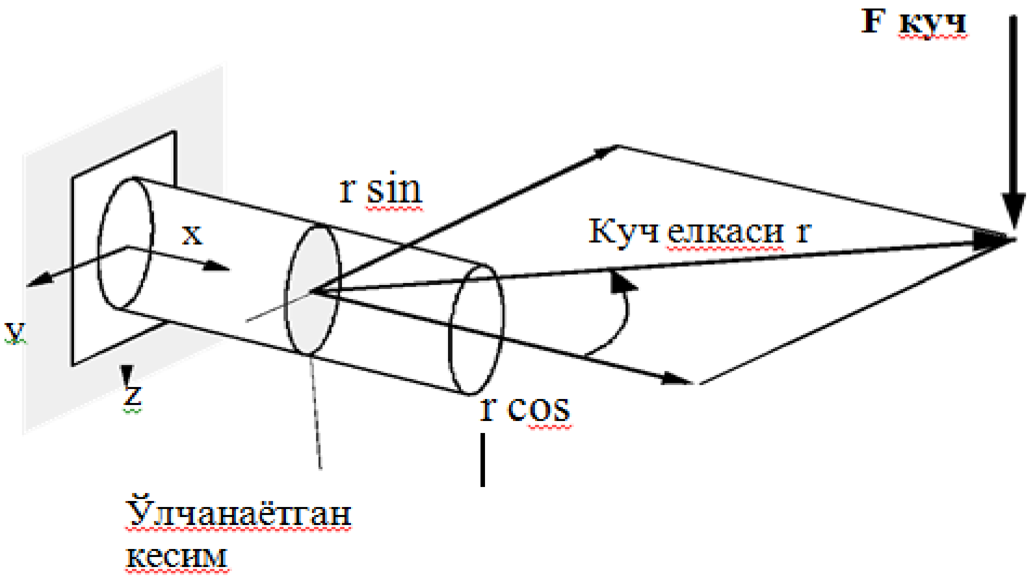
$$\sigma_v^2 = \frac{d^4}{4}\left[\left(\frac{Frcos\varphi}{I_b}\right)^2 + 4\left(\frac{Frsin\varphi}{2I_b}\right)^2\right]$$

$$\sigma_v = \frac{Frd}{2I_b}\sqrt{cos^2\varphi + sin^2\varphi}$$

sin^2 and cos^2 The sum of s is equal to 1. The allowable voltage does not depend on the angle.

$$\sigma_v = \frac{Frd}{2I_b} constant$$

This means for experiments that the value of the force F causes material erosion and is independent of bending and twisting moments. This consideration is appropriate when using the test voltage criterion. Other criteria depend on the bending moment and the twisting moment when applied.



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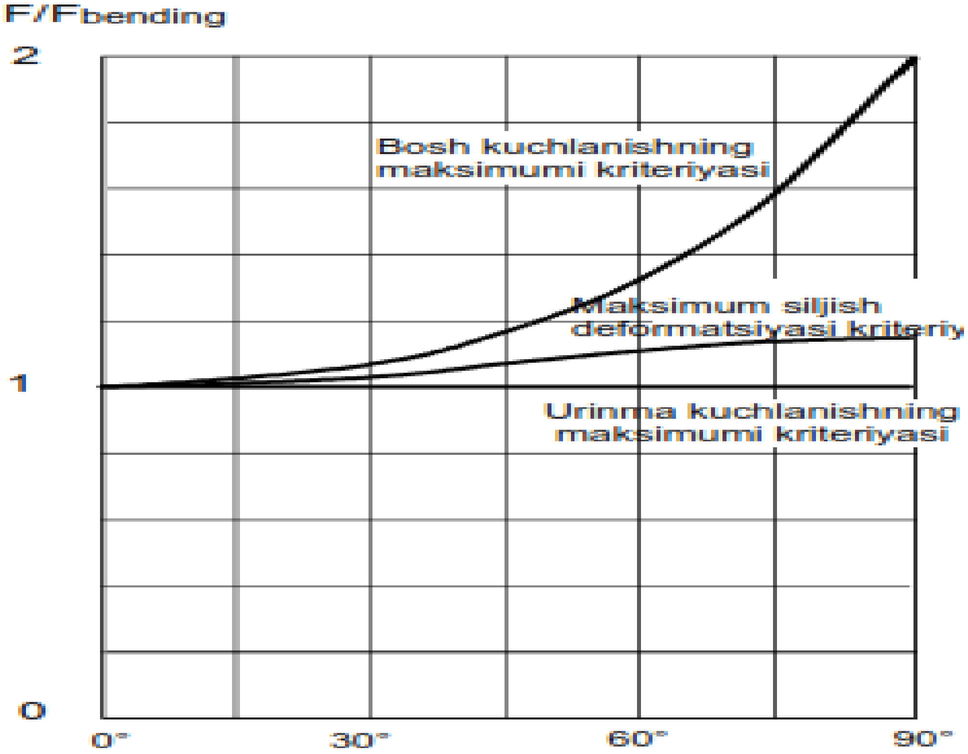
The ratio of the force F to the net bending force is graphically represented by the exact variation of the angle.



The angular position of the force
Bending moment
0% 36.6% 63.4% 100%
Torque
0% 36,6% 63,4% 100%
Change in the yield strength of force F according to different criteria

The yield point is determined when the load exceeds the elastic limit using specimens.

In this case, plastic deformation occurs in the sample. In the course of successive experiments, the material is refined, and the yield point occurs at very high stresses. There are two ways to reduce this error.

- A new sample should be used in each test. In this case, the samples must be made of exactly the same material and have the same dimensions.
- A single sample is used for testing according to different criteria, only experiments are repeated in the opposite direction on a new sample. In one of them, the test starts with a pure bending moment and ends with a pure torsional moment, and in the other one, it starts with a pure torsional moment and ends with a pure bending moment. Precision is lost by measuring the differences between two tests.

We can apply a combination of torsional and bending forces to 7 15° varying points on a quarter of the circular disk. Allowable stress is determined by adding or subtracting the load on the disk when measuring the load on each section.

To find the yield strength accurately, the residual strain must be measured continuously during the test. The test should be stopped when the proportionality between strain and stress becomes non-linear (yield limit). The plastic should not be deformed in order to avoid the effect of the concentration as much as possible.

Test: 1 Angle: 0° Direction: 1 Material: steel																		
F power, N	4	6	8	0	2	4	6	8	0									
Deformation w,	9	2	4	7	0	2	5	8	3									
Residual deformation w, 1/100 mm								0	4									
Yield strength: 28 N																		

Test: 4 Angle: 90° Direction: 1 Material: steel																		
F power, N	4	6	8	0	2	4	6											
Deformation w,	5	8	1	4	8	1	5											
Residual deformation w, 1/100							3											
Yield strength: 24N																		

Evaluation. The yield strength is determined in angles and the values in both directions are divided by the value at pure bending (0°). These values are marked on the graph (Worksheet 3). If the graphs of the results are horizontal, then the hypothesis of effort intensification is valid. If the yield strength is twice that of pure torsion, the normal stress hypothesis is valid.

Material:				
Angle	0° Pure	30°	60°	90° Pure twist
Yield strength Fl1	28	24	28	26
Direction 1	24	26	26	24
Average of 1 and 2 $F = (Fl1+Fl2)/2$	26	25	27	25
The ratio of the yield strength to the value in pure bending	1	0.96	1.04	0.96

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