

EXPERIMENTAL ANALYSIS OF TORSIONAL DEFLECTION AND ROTATION IN MECHANICAL SHAFTS

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Abstract- The presented article discusses the issue of experimentally determining the angle of rotation in structural elements subject to torsion. There are analytical expressions for the theoretical calculation of the angle of rotation of structural elements subject to torsion deformation. This is solved on the basis of the well-known Saint-Venant principle. Structural elements subject to torsion deformation are called shafts, and if the cross-section of this shaft is whole (this area is simply connected), then the torsion angle is calculated using methods the strong of materials. If there are holes along the shaft axis (parallel to its axis), the shaft cross-section will be a multiconnected area, then the issue of shaft torsion is solved analytically using the theory of functions of complex variables. Because the solution of the problem boils down to solving the Laplace equation under Neumann boundary conditions. Experimentally, the solution is carried out by the photoelasticity method. For simplicity, cylindrical shafts with rounded cross-section are considered in this article. All the experiments carried out were carried out within the elasticity limits of the material of the selected samples (the elasticity limits of different materials are different). However, sometimes due to the influence of various technological factors, a large difference arises between theoretical calculations and practical calculations. For structural elements exposed to torque, it is important to accurately determine the torsion angle. In this paper, the dependence of the angle of rotation in torsion on the amount of torque is experimentally investigated. The experiments were carried out according to two variants. The same amount of load ($p = 1$ kg) was applied to samples of constant diameter and different lengths made of aluminum material as test samples. According to the values obtained through these experiments, the change in the angle of rotation depending on the length of the axis was studied. In the second series of experiments, different amounts of loads

($m = 0.5, 1, 1.5, 2$ kg) were applied to axes of the same length ($L = 440$ mm) and constant diameter ($d = 10$ mm). Based on the results obtained, the change in deformation (proportional to the torsion angle) depending on the applied load was analyzed. The obtained results were displayed through graphs and histograms.

Keywords: Angle of Rotation, Torque, Deflection, Axis, Shaft, Strain Gauge.

1. INTRODUCTION

Under operating conditions, many structural elements are subjected to torsional deformations and lose their stability. Examples of torsion-driven parts are shafts, drills used in drilling machines, and other elements. In solving theoretical problems related to plastic deformation, it is necessary to study torsion problems experimentally to determine the tangential stresses arising in the parts, as well as to determine the tensile and impact properties of metals. During torsion testing, structural parts are subjected to stress through a torsional moment. At this time, tangential stresses appear in the samples, which cause shape changes.

These stresses mainly start from the free end of the sample and cause the sample to bend, and shape changes occur. Shape changes are characterized as the rotation of the surfaces of the sample at a given angle, starting from the end part. Many scientific studies have been conducted on the torsion of structural parts. In [1], the torsional resistance of parts with a circular cross-section prepared by a special method was investigated. The samples selected for the experiment were prepared using different processing technologies (by soaking in water and heating in an oven). It was determined that the samples heated in an oven had the highest torsional resistance.

Investigated torsional parts used in textile machinery [2]. Visual inspection, hardness testing, and metallurgical analysis of the parts were performed. It was determined that the fracture occurred mainly due to high stress concentrations. Parts made of circular cross-section composite material were investigated in [3]. The part was analyzed using the finite element method in ANSYS. The length and inner diameter of the part were chosen as geometric parameters. Also, the torsional stability problems of glass fiber reinforced shafts were investigated in [4].

In [5], the bending and torsion problems of stainless-steel parts were investigated experimentally and numerically. The length of the sample (stuns), the geometric defects of the stuns were measured, and the mechanical characteristics of the material were studied to investigate the effect of compressive loads. The values obtained as a result of the experiment were confirmed by the results obtained by the finite element method. The stability problems of rods with different tensile and compressive resistances [6] were investigated in his work. It is assumed here that the shaft is made of a variety of modular materials and loses stability when flat. Works [7], [8] are devoted to solving problems of oscillatory motion of rectangular plates and cylindrical coatings used in the oil and gas industry.

Here, the equations of oscillation motion for rectangular plates and cylindrical shells were obtained, taking into account the resistance of the external environment. [9] in his work, the problems of stability of shafts subjected to longitudinal bending under the action of compression forces were experimentally investigated. Experiments were carried out on samples with different cross-sectional lengths and widths. The experimental results were processed using the Taguchi method. The input factors that most influence the slope have been identified. A mathematical model is constructed that characterizes the change in slope depending on the applied compression force and the length of the shaft. Also, the problems of bending shafts with different cross-sectional sizes [10] were investigated in his work. Spindles made of aluminum material with different cross-sectional sizes were selected as experimental samples. Depending on the applied load and the width of the shaft, the intervals of change in the slope value are determined.

The articles [12]-[18] investigated the stress-strain state of structural elements subject to various deformations, including torsion. The materials of the structural elements in these works were homogeneous, heterogeneous, composite, functionally gradient, etc. each case was thoroughly investigated. In the presented work, the problems of torsion on shafts (beams) of various lengths with a circular cross-section made of aluminum material are experimentally investigated.

2. DESIGN OF EXPERIMENTS

The experiments for torsion tests were conducted using a W100 testing machine (Figure 1). First, the W100 test machine is prepared for the experiment and checked, that is, it is adjusted (calibrated) to obtain the correct result.

Then the linear dependence of the torsion angle on the torque is determined (within the limits of elasticity). Within the limits of the elastic limit (otherwise impossible), it is also assumed that the experimental result is compared with the theoretical calculation.

Experiment 5 test specimens made of aluminum material with different lengths were selected. The dimensions of the test specimens are as follows:

- Outer diameter of samples: $\varphi = 10$ mm;
- Specimen 1: Total length $L_1=240$ mm; Length after fastening $L_2=200$ mm;
- Specimen 2: Total length $L_1=340$ mm; Length after fastening $L_2=300$ mm;
- Specimen 3: Total length $L_1=440$ mm; Length after fastening $L_2=400$ mm;
- Specimen 4: Total length $L_1=540$ mm; Length after fastening $L_2=500$ mm;
- Specimen 5: Total length $L_1=640$ mm; Length after fastening $L_2=600$ mm;
- Applied load: 0.1 kg, 0.2; 0.5; 1; 1.5; 2; Numerical value of gravity $P=9.81$ N.

The structure of the test stand is as Figure 1.

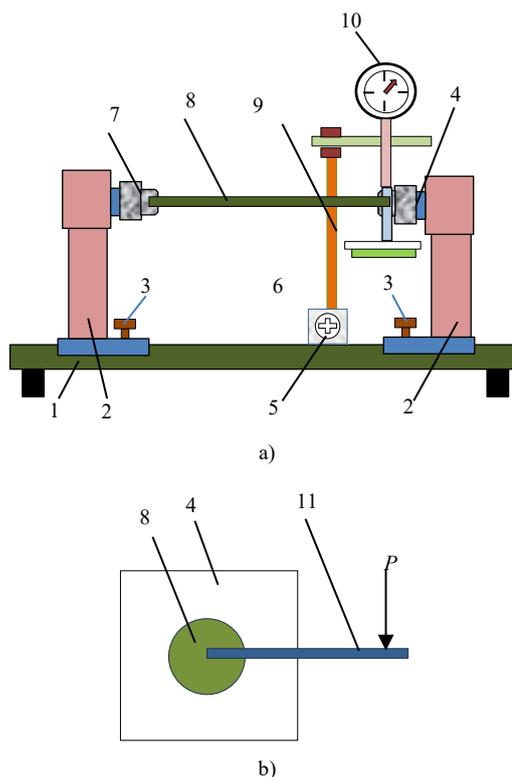


Figure 1. Structure of the torsion test stand: 1-body; 2- supports; 3- fastening elements; 4- right moving carriage; 5- magnetic holder; 6- load; 7- left fixed carriage; 8- test sample subjected to torsion; 9- bracket; 10- indicator measuring deformation

The length of the specimen and the applied load were selected as the controlled factors during the experiment. The diameter of all the selected test specimens has a constant value (10 mm). A specimen with 5 different lengths was selected. The length of the specimens is increased in 100 mm steps.

During the experiment, the test specimen (8) is placed in the left fixed chuck (7) and the right movable chuck (4). The left and right chucks are fixed in the studs (2). The indicator (10) measuring the deformation is fixed to the bracket (6). The tip of the indicator is touched to the surface of the shaft placed perpendicular to the axis of the test specimen (8) and is set to zero. The shaft is placed perpendicular to the axis of the test specimen at a distance of 100 mm. During the test, the load (6) acts on the shaft (11). The shaft (11) and the movable chuck connected to it rotate in accordance with the applied load. At this time, the shaft fixed to the chuck is subjected to torsion. The value of the resulting deformation is measured by indicator (10).

3. RESULTS OF EXPERIMENTS

Experiments were conducted in two directions. First, the angle of rotation was experimentally studied depending on the length of the sample. For this, the samples were subjected to torsion at given lengths at a constant value of the load ($m=1$ kg). The experiment was repeated 3 times. The value of the resulting deflection was measured using an indicator. The measurement results were corrected according to the adjustment error of the device. The value of the deflection measured using the indicator is taken as proportional to the angle of rotation. The experimental results for the first direction are given in Table 1.

Table 1. Values obtained as a result of the experiment

Length (mm)	The price of the displacement, based on the indicator, y (mm)	The price of the displacement based on the adjusted indicator, y (mm)	Load (kg)
Experiment No. 1			
200	0.54	0.45	1
300	0.75	0.66	1
400	0.96	0.87	1
500	1.16	1.07	1
600	1.40	1.31	1
Experiment No. 1			
200	0.54	0.45	1
300	0.77	0.68	1
400	0.95	0.86	1
500	1.18	1.09	1
600	1.40	1.31	1
Experiment No. 1			
200	0.57	0.48	1
300	0.77	0.68	1
400	0.93	0.84	1
500	1.19	1.10	1
600	1.43	1.134	1

The second series of experiments investigated the change in the angle of rotation depending on the torsional moment. For this purpose, samples with a length of $L=440$ mm and a diameter of 10 mm made of aluminum material were selected for the experiment. The length and diameter of the sample were assumed to be unchanged during the experiment. Experiments were conducted at different values of the load. The numerical value of the resulting deformation was recorded using a deformation measuring indicator. The numerical values of the indicator were taken as proportional to the torsion angle of the samples. The values obtained for the experiments in this series are given in Table 2.

Table 2. Values obtained as a result of the experiment

Load (kg)	The price of the displacement, based on the indicator, y (mm)	The price of the displacement based on the adjusted indicator, y (mm)	Length L (mm)
Experiment No. 1			
0.2	0.16	0.14	440
0.5	0.45	0.405	440
1.0	0.96	0.865	440
1.5	1.43	1.275	440
2.0	1.94	1.735	440
Experiment No. 1			
0.2	0.15	0.13	440
0.5	0.46	0.415	440
1.0	0.98	0.885	440
1.5	1.45	1.295	440
2.0	1.92	1.715	440
Experiment No. 1			
0.2	0.16	0.13	440
0.5	0.45	0.405	440
1.0	0.97	0.875	440
1.5	1.45	1.295	440
2.0	1.92	1.715	440

3. ANALYSIS OF EXPERIMENTAL RESULTS

According to the results of the first series of experiments, the value of the rotation angle increases as the length of the samples increases (Table 1). During the experiment, the deformations of the device were measured and the results were corrected in accordance with this value. Therefore, we accept the corrected values in the analysis of the results. According to the results of the first series of experiments, the dependence of the rotation angle on the length of the sample is analyzed. The smallest value was observed in the sample with a length of $L=200$ mm.

Here, the indicator value of the indicator (this value is proportional to the rotation angle) was taken as 0.45 mm. The largest value was observed in the sample with a length of $L=600$ mm. This value is equal to 1.32 mm. As the sample length increases from 200 mm to 300 mm, the deflection of the shaft perpendicular to the sample axis (which is proportional to the rotation angle) increases by 46%, from 300 mm to 400 mm by 31%, from 400 mm to 500 mm by 22%, and from 500 mm to 600 mm by 22% (Figure 2). As can be seen, the largest change in the value of the slope (43%) was observed when the length of the shaft was increased from 200 mm to 300 mm. As the length value was gradually increased, the percentage change in the slope values decreased.

The second series of experiments investigated the variation of the angle of rotation depending on the torque (Table 2). Here, the length of the sample was assumed to be constant ($L=440$ mm). Experiments were conducted by gradually increasing the load value. The smallest value of the deflection corresponded to the load value of 0.2 kg. Here, the deflection value was 0.14 mm. The largest value was obtained at the load value of 2 kg. At this load limit, the deflection value was 1.735 mm.

When the load value applied to the shaft perpendicular to the axis of the sample was increased in 0.2-0.5 kg, the deflection value was 0.265 mm (190%); when it was increased in 0.5-1 kg, it was 0.46 mm (113%); when it was increased in 1-1.5 mm, it was 0.41 mm (47%); When increasing in 1.5-2 mm, the cost of the coating increases by 0.46 mm (36%) (Figure 3).

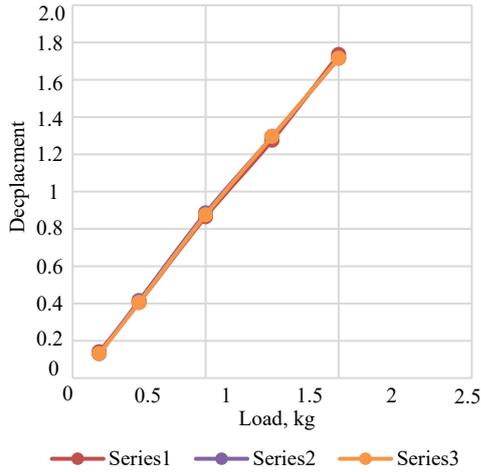


Figure 2. Variation of the wear (angle of rotation) depending on the length of the shaft

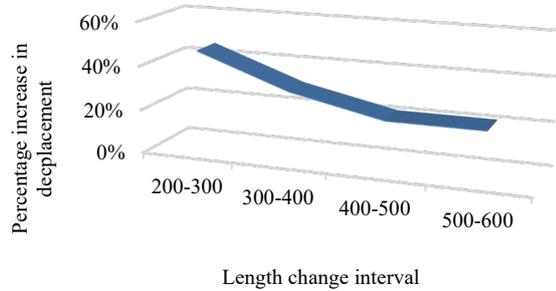


Figure 3. Percentage increase in wear depending on the shaft length change interval

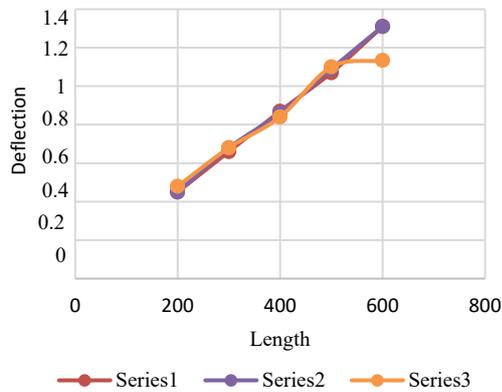


Figure 4. Variation of the wear (angle of rotation) depending on the applied load

As can be seen from the graph, with a small increase in the price of the cargo, the price of the scrap increases sharply (190%). With a subsequent increase in the price of the cargo, the percentage increase in the price of the scrap gradually decreases. The largest percentage increase in the price of the scrap was observed when the price of the cargo was increased from 0.2 kg to 0.5 kg. This value was 190%, respectively. The smallest percentage increase in the price was obtained when the price of the cargo was increased from 1.5 kg to 2 kg. Here, the percentage increase in the scrap was 36%.

5. THEORETICAL CALCULATION OF THE TORSION ANGLE

The result of the experiment is theoretically calculated and compared. For this, the expression of the dependence of the torsion angle on the torque is used (Figure 5).

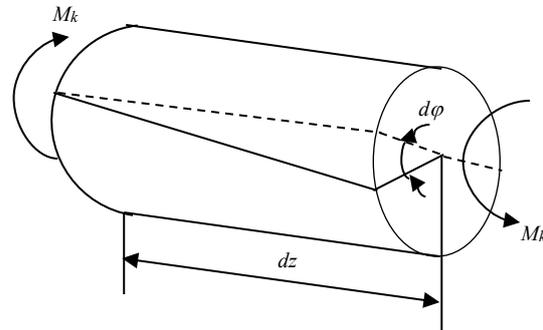


Figure 5. Circular cross-section shaft subjected to torsion

The expressions for theoretically calculating the rotation angle are given below.

$$\varphi_z = \frac{M_A \times z}{G J_\rho} \tag{1}$$

$$J_\rho = \frac{\pi D^4}{32} \tag{2}$$

$$G = \frac{E}{2(1 + \mu)} \tag{3}$$

Table 3. Theoretically obtained values

Length (mm)	The value characterizing the angle of rotation γ (mm)	Shaft diameter (mm)	Load (kg)
Experiment No. 1			
200	0.56	10	1
300	0.78	10	1
400	0.99	10	1
500	1.18	10	1
600	1.45	10	1

The theoretically obtained values of the parameter characterizing the rotation angle are given in Table 3. As can be seen, there is a difference of approximately 1% between the experimental and theoretical values.

6. CONCLUSION AND DISCUSSIONS

The analysis of the torsional stability of shafts used in machines, mechanisms and other types of structural parts is of great importance for their reliable and efficient operation. One of the main parameters in the torsional analysis of shafts is the angle of rotation resulting from torsion. The angle of rotation is created when a torsional moment is applied to the shaft. The angle of rotation, as a geometric parameter, directly affects the longevity and safe operation of the shaft. Therefore, the practical determination of the angle of rotation in shafts subjected to torsion is of great importance for engineering calculations and design.

In the article under review, the change in the angle of rotation due to the length of the shaft, the applied load and the torque was practically studied. Two series of

experiments were conducted on a torsion testing machine. First, experiments were conducted on test specimens made of aluminum material with a total length of 240 mm, 340 mm, 440 mm, 540 mm, 640 mm, and a diameter of 10 mm. The load was applied perpendicular to the axis of the shaft at a distance of 53 mm, and as a result, a torque was created. As a result of the torque, the test specimens were subjected to torsion and a torque angle was formed. The deformation on samples of different lengths was measured using a protractor indicator. The following main results were obtained:

1. The effect of the shaft length on the rotation angle was studied in the first series of experiments. The smallest shaft length ($L=200$ mm) had the smallest deflection. The largest deflection value was formed in the shaft length ($L=600$ mm). The percentage change in the deflection value was observed in small intervals of the shaft length. Thus, when the length of the sample was increased from 200mm to 300mm, the deflection value (the angle of rotation is proportional to the deflection value) increased by 46%. When the deflection value was increased from 500 mm to 600 mm, the deflection value increased by 22%. Here, the deflection is directly proportional to the rotation angle. As can be seen, as the intervals of change in the length of the sample increase, the percentage increase in the angle of rotation decreases.

2. As a result of the experiments conducted in the second series, the effect of the torque on the angle of rotation was investigated. Here, a gradually increasing load was applied to a shaft with constant cross-sectional dimensions and length ($L=440$ mm). The smallest value of the angle of rotation was formed at small values of the load. At the largest value of the load, the largest value of the angle of rotation was formed. That is, the results obtained during the experiment are consistent with theoretical expressions. At small values of the load change interval, that is, when the applied load was increased from 0.5 kg to 1 kg, the value of the deflection increased by 190%. The angle of rotation also changed proportionally to this value. When the applied load value was increased from 1.5 kg to 2 kg, the value of the deflection increased by 36%. As can be seen, the numerical value of the angle of rotation increased sharply in the small value interval of the load. At large value intervals of the applied load, the percentage of change in the numerical value of the angle of rotation decreases.

Based on the results obtained, engineers can predict deformations in mechanical systems by knowing the values of the rotation angle change and ensure their reliable and efficient operation. Also, accurate determination of rotation angle creates basis for optimizing mechanical designs, reducing the weight of structural parts and, as a result, increasing economic efficiency.

REFERENCES

[1] J. Bernaczek, M. Debski, P. Mikulski, "Analysis of Torsional Strength of Pa2200 Material Shape Additively with the Selective Laser Sintering Technology", *Advances in Science and Technology Research Journal*, Vol. 17, pp. 12-24, 2023.

[2] T. Sekercioglu, "Failure Analysis of Torsion Bar of Projectile Weaving Machine", *J Fail. Anal. and Preven*, Vol. 10, pp. 363-366, 2010.

[3] B. Beylergil, "Design and Discrete Optimization of Hybrid Aluminum Composite Drive Shafts for Automotive Industry", *Journal of Eng. Research*, Vol. 9, No. 3B, pp. 248-263, September 2021.

[4] E. Boru, "Torsional Strengthening of Steel I Beams with Different GFRP Configurations", *Structures*, Vol. 56, pp. 104-859, October 2023.

[5] F.R. Sarquis, L.R.O. de Lima, P.C.G. da S. Vellasco, M.C. Rodrigues, "Experimental and Numerical Investigation of Hot-Rolled Stainless Steel Equal Leg Angles Under Compression", *Thin-Walled Structures*, Vol. 151, pp. 106-742, June 2020.

[6] N.S. Rzayev, R.D. Aliyev, "Planar Stability of an Elastic, Plastic Beam Differently Resisting to Tension and Compression", *International Journal on Technical and Physical Problems of Engineering (IJTPE)*, Issue 60, Vol. 16, No. 3, pp. 1-7, September 2024.

[7] H. Mirzayev, N.S. Rzayev, "Experimental Study of Bending by the Taguchi Method on Beams Subject to Bending Deformation", *Journal of Baku Engineering University, Mechanical and Industrial Engineering*, No. 2, pp. 59-66, 2022.

[8] N.S. Rzayev, V.F. Gahramanov, R.D. Aliyev, N.I. Hasanov, "Free Oscillations of Rectangular Plates Used in Construction of Oil and Gas Facilities", *International Journal on Technical and Physical Problems of Engineering (IJTPE)*, Issue 60, Vol. 16, No. 3, pp. 375-381, September 2024.

[9] N.S. Rzayev, A.H. Guliyev, V.F. Gahramanov, N.I. Hasanov, "Cylindrical Shape of the Free Oscillation of a Rectangular Orthotropic Plate Located on an Inhomogeneous Viscoelastic Base", *International Journal on Technical and Physical Problems of Engineering (IJTPE)*, Issue 61, Vol. 16, No. 4, pp. 276-282, December 2024.

[10] N.S. Rzayev, A.I. Hasanov, V.F. Gahramanov, V.I. Salmanov, K.A. Gafarbayli, "Experimental and Theoretical Analysis of Rod Deflection Under Compressive Loading", *International Journal on Technical and Physical Problems of Engineering (IJTPE)*, Issue 62, Vol. 17, No. 1, pp. 330-336, March 2025.

[11] N.S. Rzayev, V.F. Gahramanov, I.N. Shirinzade, S.A. Ganiyeva, "Experimental Study of Bending of Rods with Different Cross-Sectional Sizes by Taguchi Method", *International Journal on Technical and Physical Problems of Engineering (IJTPE)*, Issue 62, Vol. 17, No. 1, pp. 212-218, March 2025.

[12] R.A. Iskanderov, O.Y. Efendiev, "Analytical Study of the Effect of Porosity on the Mechanical Properties of the Material", *Engineering Mechanics, Scientific and Technical Journal*, Issue 14, Vol. 6, No. 2, pp. 37-40, September 2023.

[13] R.A. Iskanderov, "Studies of the Effect of Pre-Buckling of a Reinforced Cylindrical Shell Filled with a

Medium on Critical Stresses of General Loss of Stability”, Proceedings of Higher Educational Institutions, Aviation Technology, Kazan, No. 4, pp. 67-69, 2010.

[14] R.A. Iskanderov, J.M. Tabatabaei, “Vibrations of Fluid-Filled Inhomogeneous Cylindrical Shells Strengthened with Lateral Ribs”, International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 42, Vol. 12, No. 1, pp. 121-125, March 2020.

[15] R.A. Iskanderov, H.M. Shafiei Matanagh, “Free Vibrations of a Conical Shell with Spring Associated Mass and Stiffened with a Cross System of Ribs in Medium”, International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 43, Vol. 12, No. 2, pp. 1-5, June 2020.

[16] R.A. Iskanderov, J.S. Mammadov, D.A. Mahmudov, “Substantiation of Initial Provisions of Construction of a Methodology for Modeling Corrosion Degradation”, Issue 60, Vol. 16, No. 3, pp. 274-280, September 2024.

[17] A.S. Kairov, R.A. Iskanderov, V.A. Kairov, L.A. Latanskaya, “Investigation of Natural Vibrations of Rib-Reinforced Cylindrical Shells with Holes Using Finite Element Method and Holographic Interferometry”, Technical and Physical Problems of Engineering (IJTPE), Issue 62, Vol. 17, No. 1, pp. 101-108, March 2025.

[18] A.S. Kairov, R.A. Iskanderov, V.A. Kairov, L.A. Latanskaya, S.A. Valiyeva, “Mathematical Simulation of the Stress-Strain State of Rib-Reinforced Multilayer Cylindrical Shells Under Longitudinal Impulse Loading”, International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 59, Vol. 16, No. 2, pp. 361-367, June 2024.

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