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SELECTION OF THE WORKPIECE TYPE FOR THE STEEL REINFORCEMENT ROPE PRODUCTION

Reinforcing ropes are one of the most common types of products, consisting of seven steel wires widely used in engineering, construction, agriculture, and other industries. These products are in high demand in these industries due to their higher strength than reinforcing ropes consisting of 2 and 3 wires. In the production of Kaz-metiz LLP (Kaz-metiz), a wire was produced from two types of blanks (patented and chemically processed) to improve the mechanical properties of the rope. The blanks were tested for tension and bending. During the tensile test on the REM-100-M-1 stand, the first sample had high rates of breaking force and tensile strength of the wire. During the bending test, the ability of blanks to resist destruction under alternating deformations was determined. After the tests, rope samples with dimensions L = 520 mm and a diameter of 12 mm were made from these blanks for further testing for tensile, compression, and bending on the RGM-600-M-1 test bench. Based on the results of experimental and industrial studies, a type of blank was selected that meets the requirements for finished products manufactured by Kaz-metiz LLP (Kaz-metiz).

Keywords: reinforcing ropes, testing, compression, metrological support, workpieces.

Introduction

Seven-wire reinforcing ropes are prestressed reinforcement and are a strand consisting of six wires of the outer layer, twisted in a spiral around one central wire. The raw material for the manufacture of reinforcing ropes is wire rods with a diameter of 11.00 mm of steel grade 80. The quality of wire rods is one of the main factors determining technical and economic indicators and product quality of steel wire production [1]. Drawing defects are unacceptable and affect the quality of the finished product [2].

Patenting is in the fact that the wire, passing as an unfolded thread through the furnace muffle, is heated to a temperature of 860–9400 C, then enters the bath, in which it is cooled to a temperature of 410–5500C, after which it slowly cools in the air [3]. The patented stock of reinforcing ropes has a higher strength and elasticity [4] than the wire quenched and tempered after drawing: in the first case, mechanical strengthening during drawing is added to the hardening achieved during heat treatment, while in the second case, this mechanical strengthening is significantly reduced as a result of recrystallization occurring during heating for hardening.Ropes are made exclusively from hard-worked wire with a total reduction of approximately 70 to 80 %. Seven-wire reinforcing ropes is a strand consisting of one central wire and six wires of the outer layer, twisted in a spiral around the central wire (Fig. 1) [5].

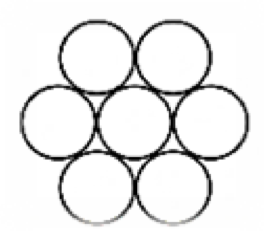


Figure 1. Construction of a seven-wire reinforcement rope 1×7

The rest of the article is structured as follows: Section 2 contains the experimental part carried out in Kaz-metiz LLP, two samples with a diameter of 4.10 mm of a patented and chemically processed workpiece were made for the experiment. The results of the experiment are given in the conclusion section.

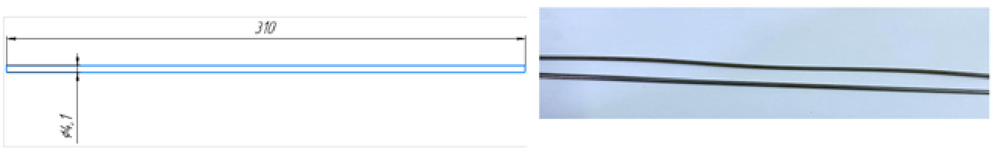
The experimental part

The main purpose of the experiment is to choose a method for obtaining a workpiece for the manufacture of reinforcing rope with high mechanical properties.

To do this, Kaz-metiz LLP (Kaz-metiz) produced two samples with a diameter of 4.10 mm of a patented and chemically processed billet (Table 1) (Fig. 2). The chemical composition and drawing technology of the workpieces are identical.

Table 1 – Technology for obtaining workpieces (samples)

Sample number	Type of sample processing	Geometric dimensions	Wire Processing Method	Drawing speed, m/s	Type of oil for drawing
№1	Patented	Diameter - 4.10 mm, length - 310 mm	Patented	3,0 m/s	LUBIFIL VF3179
№2	Chemically processed		Chemically processed		SBS-Y



(a) (b)

Figure 2 – Samples for the experiment: (a) diagram; (b)photo

During the tests, testing machines and measuring instruments were used, the metrological characteristics of which are given in table 2.

Table 2 – Metrological assurance of tests

Name of the measured parameter, designation	Unit of physical quantity	Name, type of test device, regulatory document	Measuring range	Accuracy class, measurement error
Wire length, L	mm	Line-1000, State Standard 427-75	300	0,2
Wire diameter, ∅	mm	Micrometer MC, 0-25 State Standard 6507-90	0-25	0,01
Breaking force of wire, P_{max}	kN	Universal test bench, REM-100-M-1	4-100 kN	no more than 1%
Wire bend, N_b	-	Test bench WJJ–6C	not listed in the test stand passport	
Rope diameter, ∅	mm	Calipers, CP- II -250-0,05 State Standard 166-89	0-250	0,1
Rope breaking force,P_{max}	kN	Test bench, RGM-600-M-1	24-600 kN	no more than 1%

To determine the breaking force P and the tensile strength of the wire □B, the workpieces were tested for tensile strength in accordance with the source [6].

Breaking force (P) - the maximum force required to separate the sample.

The temporary tear resistance (tensile strength σB) – is the stress corresponding to the greatest force Pmax preceding the rupture of the sample. The time resistance to rupture was determined by the formula:

$$\sigma_{max} = P_{max}/F_0$$

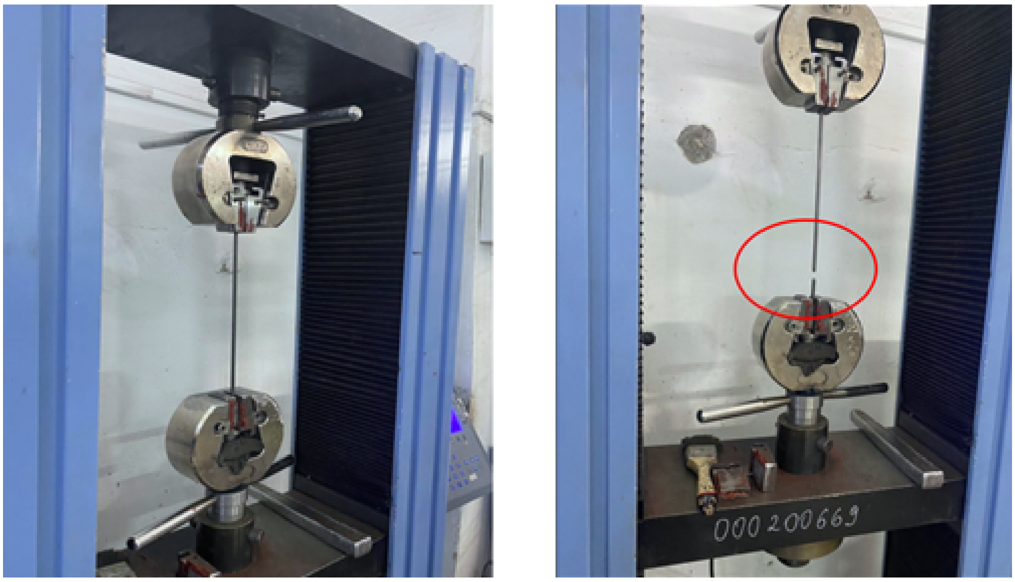
if, Pmax is the breaking force of the wire, kN

F_0-wire cross-sectional area,mm^2.

The test was carried out on the SEM-100-M-1 and in accordance with the requirements of the regulatory document (Fig. 3) [7]. The wire diameter was measured in mutually perpendicular directions using a micrometer MC 0-25 (table 3).Mechanical tests of samples on the machine are carried out by deforming the sample to destruction with controlled movement of the active traverse. The cross - sectional area of the wire was determined by the formula:

$$F = \frac{\pi \quad d^2}{4} \quad (2)$$

The test results are shown in Table 4.



(a) (b)

Figure 3 – Testing the sample for rupture on the bench REM-100-M-1:
(a) - type of the stand; (b) - wire break (highlighted in red - wire break area)

Table 3 – Measurement of the sample diameter with a micrometer MC 0-25 [8]

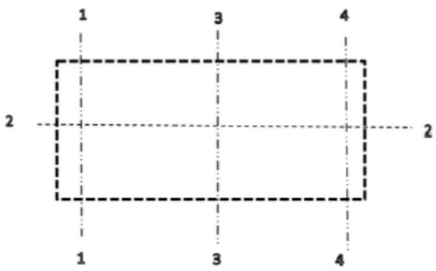
Measurement sketch	Sample	Nominal diameter, mm	Actual size, mm
	№1	4,12 – 4,13	4,10±0,04
	№2	4,11 – 4,13	

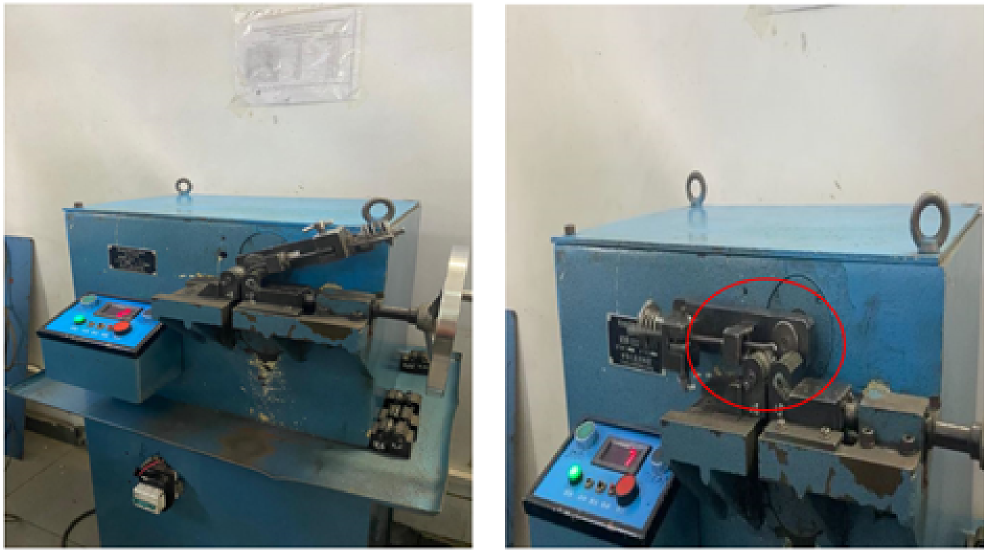
Table 4 – Tensile test results

Sample	Breaking force (P), N	Wire cross-sectional area F, mm^2	Temporary tear resistance, N /mm^2
№1	26000	13,32	1952
№2	24650	13,26	1858

Bending tests were carried out on the test bench WJJ–6C in accordance with the requirements of the standard in order to determine the ability of the metal to withstand repeated bending and stretching (Fig.4) [6]. Metrological support of tests according to Table 2. The essence of the method consists in alternately bending the sample to the right and left at an angle of 90 degrees. Alternating stresses are created at the inflection point, which will lead the sample to a characteristic destruction. This type of test shows the ability to resist destruction with alternating deformations [9].

If, after testing, there are no external defects on the sample surface in the form of cracks, tears, delaminations, etc., then the material is considered to have passed the test. The index of plasticity is the number of bends before destruction [9].

In the regulatory document of the enterprises of Kaz-Metiz LLP, where bending tests are provided, as a rule, the minimum number of kinks for this type of product is indicated [9]. If the sample fails at the specified minimum value or more, the sample passed the test. Even for samples withstanding the number of bends, it is necessary to pay attention to the nature of the destruction.



(a) (b)

Figure 4 – Test bench WJJ-6C:
type of the device; (b) wire bending moment (highlighted in red - wire break area)

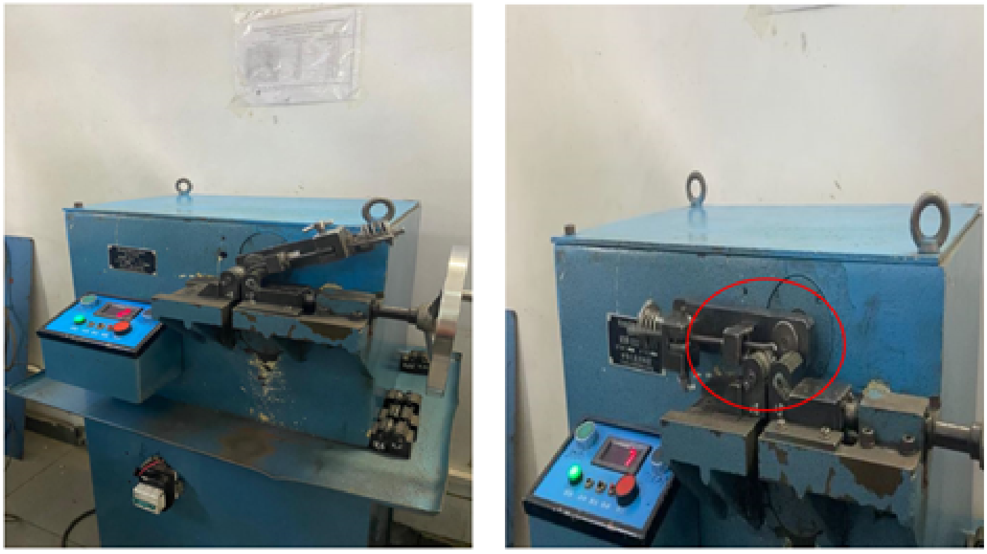
If, after the test, there are no external defects on the surface of the sample in the form of cracks, ruptures, delaminations, etc., then the sample is considered to have passed the test [9]. The test results are shown in Table 6.

Table 6 – Tensile test results

Sample	Nominal bending value, $N_b > 9$ [6]
№1	15
№2	10

The results of bending tests given in Table 6 meet the requirements of regulatory documents, according to the results it can be concluded that sample No. 1 has high performance characteristics [6]. No external defects were found on the surface of the two samples after testing.

Corresponding reinforcing ropes are made from these samples, which are tested for rupture, metrological support of tests according to Table 2. The dimensions of the reinforcing ropes sample for tensile testing is: L = 520mm, diameter is 12mm. The rupture tests were carried out on the RGM-600-M-1 test bench (Fig. 5). The universal testing machine RGM-600-M-1 meets the requirements of the standards and is designed for mechanical tests in the mode of stretching, compression and bending of samples made of steel and other materials [6].



(a) (b)

Figure 5. Test stand RGM-600-M-1:

(a) loading the collet with the tested reinforcing rope into the clamp assembly; (b) type of the test sample

The results of the breaking force tests are shown in Figure 6.

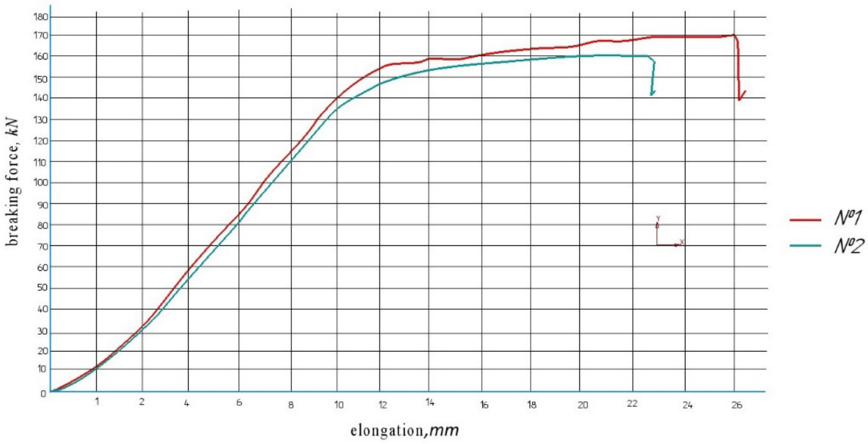


Figure 6. The result of testing reinforcement ropes for rupture

Results and discussion

Based on the work carried out, it was found that samples from a patented billet during tensile testing show high rates (Table 4) compared to a chemically treated billet, which shows higher characteristics, such as strength and deformation of the metal under tensile loading. The bending test of the samples (Table 6) determined the ability of the patented workpiece to have a higher fracture resistance under alternating deformations. According to the results of testing the reinforcing ropes for rupture, the patented blank showed the value of the ultimate breaking force by 5 %, and the elongation by 8 % (Fig. 7) more than the chemically treated one, which shows the best physical and mechanical properties of the reinforcing ropes from the patented blank.

Conclusion. Based on the results of production studies, it was established that in order to develop a high-quality reinforcing rope, it is important for an enterprise to process patenting, which provides high physical and mechanical properties. On the basis of the work carried out, changes were made to the technological regulations in Kaz-metiz LLP (Kaz-metiz) for the production of a rope with a diameter of 12.00 mm.

REFERENCES

1 **Adamchuk, S. V.** Resursosberegayushhaya texnologiya proizvodstva armaturny`x kanatov dlya predvaritel`no napryazhenny`x zhelezobetonny`x konstrukcij [Resource-saving technology for production of reinforcement ropes for prestressed reinforced concrete structures] : Dissertation. – Magnitogorsk : Izd-vo Magnitogorsk State Technical University, 2002. – 301 p.

2 **Buzauova, T. Sivachenko, L., Aizhambaeva, S., Zhuldyzai, K., Abdugaliyeva, G.** Research of the unacceptable defects causes in the manufacture of reinforcing rope. Journal of applied engineering science. – 2023. Vol. 21 № 1. – P. 1–5. DOI: https://doi.org/10.5937/jaes0-36346.

3 **Borisenko, A. Lucenko, V., Lucenko, O., Kurenkova, T., Seregina, E., Demidov, A. V.** Struktura i svojstva patentirovannoj vy`sokouglerodistoj provoloki [Structure and properties of patented high carbon wire]. / Lit`e i metallurgiya. 2012. – 4 (68), – P. 11–20.

4 **Mezin, I. Yu. Limarev, A. S., Salganik, V. M., Gun, I. G.** Vliyanie rezhimov patentirovaniya uglerodistoj provoloki na ee svojstva [Influence of carbon wire patenting modes on its properties]. Magnitogorskij gosudarstvenny`j texnicheskij universitet im. G. I. Nosova, Magnitogorsk : Izd-vo Magnitogorskij gosudarstvenny`j texnicheskij universitet, 2020. – 245 p.

5 GOST 13840-68. Armaturny`e stal`ny`e kanaty` 1x7. Texnicheskie xarakteristiki [Reinforcement steel ropes 1x7. Specifications]. – Vved. 1990.01.23. – Moscow : Izd-vo standartov, 1990. –11 p.

6 GOST 7348-81. Provoloka iz uglerodistoj stali dlya armirovaniya predvaritel`no napryazhenny`x zhelezobetonny`x konstrukcij. Texnicheskie xarakteristiki [Carbon steel wire for reinforcement of prestressed reinforced concrete structures. Specifications]. – Vved. 1983.01.01. – Moscow : Standartinform, 2003. – 8 p.

7 GOST 12004-81. Stal` armaturnaya. Metody` ispy`taniya na rastyazhenie [Reinforcement steel. Tensile test methods]. –Vved. 1983.07.01. – Moscow: Standartinform, 2009. –12 p.

8 GOST 6507-90. Mikrometry`. Texnicheskie usloviya [Micrometers. Specifications]. –Vved. 1991.01.01. – Moscow : Izd-vo standartov, 2000. –12 p.

9 Vnutrennie texnologicheskie reglamenty` TOO Kaz Metiz [Internal process regulations of Kaz Metiz LLP]. – № 1. – St. 10 s izm. i dopol. v red. ot 11.02.2009.

10 GOST 28840-90. Mashiny` dlya ispy`taniya materialov na rastyazhenie, szhatie i izgib. Obshhie texnicheskie trebovaniya [Machines for testing materials for tension, compression and bending. General Technical Requirements]. –Vved. 1993.01.01. – Moscow : Izd-vo standartov, 2004. – 8 p.

Material received on 22.06.23.

СПИСОК ИСПОЛЬЗОВАННЫХ ИСТОЧНИКОВ

1 **Адамчук, С. В.** Ресурсосберегающая технология производства арматурных канатов для предварительно напряженных железобетонных конструкций. Диссертация. Магнитогорский государственный технический университет имени Г. И. Носова, 2002. – 301 с.

2 **Buzauova, T. Sivachenko, L., Aizhambaeva, S., Zhuldyzai, K., Abdugaliyeva, G**. Research of the unacceptable defects causes in the manufacture of reinforcing rope. Journal of applied engineering science Vol. 21 № 1 2023. – P. 1–5. DOI: https://doi.org/10.5937/jaes0-36346.

3 **Борисенко, А. Ю., Луценко, В. А., Луценко, О. В., Куренкова, Т. П., Серегина, Е. С., Демидов, А. В.** Структура и свойства патентированной высокоуглеродистой проволоки. Литье и металлургия. 4 (68), 2012. – С. 11–20.

4 **Мезин, И. Ю., Лимарев, А. С., Салганик, В. М., Гун, И. Г.** Влияние режимов патентирования углеродистой проволоки на ее свойства. Магнитогорск : Магнитогорский государственный технический университет, Россия. 2020. – 245 с.

5 ГОСТ 13840-68. Арматурные стальные канаты 1х7. Технические характеристики. – Введ. 1990.01.23. – М. : Изд-во стандартов, 1990. – 11 с.

6 ГОСТ 7348-81. Проволока из углеродистой стали для армирования предварительно напряженных железобетонных конструкций. Технические характеристики. – Введ. 1983.01.01. – М. : Стандартинформ, 2003. – 8 с.

7 ГОСТ 12004-81. Сталь арматурная. Методы испытания на растяжение. – Введ. 1983.07.01. – М. : Стандартинформ, 2009. – 12 с.

8 ГОСТ 6507-90. Микрометры. Технические условия. –Введ. 1991.01.01. – М. : Изд-во стандартов, 2000. –12 с.

9. «Внутренние технологические регламенты ТОО Kaz Metiz» от 02.10.2007 № 45127-41 2009 г. – № 1. – Ст. 10 с изм. и допол. в ред. от 11.02.2009.

10 ГОСТ 28840-90. Машины для испытания материалов на растяжение, сжатие и изгиб. Общие технические требования. – Введ. 1993.01.01. –М. : Изд-во стандартов, 2004. – 8 с.

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БОЛАТТЫ АРМАТУРАЛЫҚ АРҚАНДЫ ӨНДІРУ ҮШІН ДАЙЫНДАМА ТҮРІН ТАҢДАУ

Арматуралық арқандар – машинажасау, құрылыс, ауыл шаруашылығы және т.б. салаларда кеңінен қолданыс тапқан жеті болат сымнан тұратын ең көп таралған өнімнің бірі. Аталған салаларда бұл өнім 2 және 3 сымнан тұратын арматуралық арқандарға қарағанда беріктігімен жоғары сұранысқа ие. ЖШС «Kaz-metiz» (Каз-метиз) өндірісінде арқанның механикалық қасиеттерін арттыру мақсатында екі түрлі дайындамадан (патенттелген және химиялық өңделген) сым әзірленді. Дайындамалар үзілуге және иілуге сыналды. РЭМ-100-М-1 сынақ стендінде созылу сынағы кезінде бірінші үлгінің созылу күші және үзілуге уақытша төзімділік көрсеткіштері жоғары болды. Иілу сынақтары кезінде дайындамалардың ауыспалы деформациялар кезінде бұзылуға қарсы тұру қабілеті анықталды. РГМ-600-М-1 сынақ стендінде үзілуге, қысылуға, иілуге сынау мақсатымен сынақтар жүргізіліп болғаннан кейін осы дайындамалардан L = 520 мм, диаметрі 12 мм арқан үлгілері әзірленді. Тәжірибелік және өндірістік зерттеулер нәтижесінде ЖШС «Kaz-metiz» (Каз-метиз) өндірісінің дайын өнімдеріне қойылатын талаптарына сәйкес дайындаманың түрі таңдалды.

Кілтті сөздер: арматуралық арқандар, сынақ, қысылу, метрологиялық қамтамасыз ету, дайындама.

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ВЫБОР ВИДА ЗАГОТОВКИ ДЛЯ ПРОИЗВОДСТВА СТАЛЬНОГО АРМАТУРНОГО КАНАТА

Арматурные канаты - один из самых распространенных видов изделий, состоящий из семи стальных проволок, нашедших широкое применение в машиностроении, строительстве, сельском хозяйстве и в других отраслях. В указанных отраслях данная продукция пользуется повышенным спросом по причине более высокой прочности, чем арматурные канаты, состоящие из 2-х и 3-х проволок. В производстве ТОО «Kaz-metiz» (Каз-метиз) с целью повышения механических свойств каната произведена проволока из двух видов заготовок (патентированная и химически обработанная). Заготовки испытывались на растяжение и на изгиб. При испытании на растяжение на стенде РЭМ-100-М-1 у первого образца были высокие показатели разрывного усилия и временного сопротивления к разрыву проволоки. Во время испытании *на изгиб определены способность заготовок сопротивляться разрушению при знакопеременных деформациях. После проведенных испытании из данных заготовок изготовлены образцы каната размерами L = 520мм, диаметром 12мм для дальнейшего испытания их на разрыв, сжатие и изгиб на испытательном стенде РГМ-600-М-1. По результатам экспериментальных и промышленных исследовании выбран вид заготовки, который отвечает требованиям, предъявляемым к готовой продукции производства ТОО «Kaz-metiz» (Каз-метиз).*

Ключевые слова: арматурные канаты, испытание, сжатия, метрологическое обеспечение, заготовка.

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