Tension testing of steel welded belts of the saw gaskets of a linter machine

Farhod Ibragimov*, *Ortiq* Abzoirov, and *Lola* Zhamolova

Institute of Mechanics and Seismic Stability of Structures of the Academy of Sciences of the Republic of Uzbekistan, Tashkent, 100125, Uzbekistan

Abstract. The results of tensile testing of steel welded belts of saw blades of a linter machine are presented in the article. A universal testing machine was used to find the tensile stability of steel welded belts of saw gaskets of a linter machine. The results of tensile tests on the study of steel welded belts of gaskets with a thickness of 1.5 mm and 2 mm using electric arc welding and kemppi welding (a carbon dioxide welding technology) showed that in order to stretch welded belts up to 5 mm, 2820 N is necessary for a thickness of belts of 1.5 mm for electric arc welding, and 2900 N for kemppi; with a thickness of 2 mm, 3260 N is necessary for electric arc welding and 4440 N for kemppi welding. The results of the tensile tests of welded belts showed that when welding the belts of steel gaskets, both electric arc and kemppi welding can be used. In the production of steel belts of gaskets, it is appropriate to use kemppi, because the minimum thermal stress is reached in the welding zone.

1 Introduction

In the existing saw cylinders of cotton gins, gaskets made of AK5M2 aluminum (Figure 1a) are used; they are installed on the shaft along the entire length between the saw blades [1]. For example, the operation of existing linter machines has shown that the design of saw cylinders and ribs does not provide the necessary assembly accuracy for saw blades to enter the rib slot [2].

The assembly of ribs is extremely complex and requires great installation accuracy. The existing principle of assembling rib grates according to the method of individual fitting follows from the unresolved issues of accuracy, the low-tech design of the rib grate and its assembly units [3].

The reason for the low reliability of the rib grate of linter machines is the accelerated wear of the ribs, which leads to mechanical damage and premature exit of furry seeds from the working chamber of the linter machine.

To eliminate these shortcomings, it is necessary to identify the reasons for the low reliability of the “saw-rib” system and develop new designs that can improve the performance of cotton gins while maintaining product quality and reducing its cost. In addition, most of the ribs wear out due to direct contact with the saws due to their warping and assembly error

* Corresponding author: farkhod.ibragimov.1985@mail.ru

 https://doi.org/10.1051/e3sconf/202339006015

of the saw cylinder [2, 3], which leads to an increase in the gap between the ribs in the working area and disruption of the linting process.

When assembling the saw cylinder of a linter machine, the technological gaps between the saw blades fluctuate over a wide range. As a result, saw blades exert additional lateral pressure on the ribs, which leads to seeds and lint damage, and intensive wear of ribs [2].

To avoid the above disadvantages of the saw cylinder of a linter machine, there are the following design and technological solutions [4]:

- reducing the weight of the saw gasket by making through holes in the blade between the outer and inner diameters;
- ensuring a balance between the saw gaskets due to the fact that two adjacent holes on the blade, located on the diametrically opposite side from the welds, are made of reduced size;
- ensuring the coordination of the saw blades on the saw cylinder due to the fact that a second belt with holes is installed in the inner hole of the blade;
- ensuring the rigidity of the fastening of the saw blades in the saw cylinder due to the fact that in the inner surface of the blade, on the diametrically opposite side from the weld, a protrusion is made in the form of a straight-sided slot with the possibility of the protrusion entering the hole of the second belt and the groove of the saw cylinder shaft (Figure 1b).
-

a)

b)

a - AK5M2; b - Steel 3

Fig. 1. Samples of gaskets.

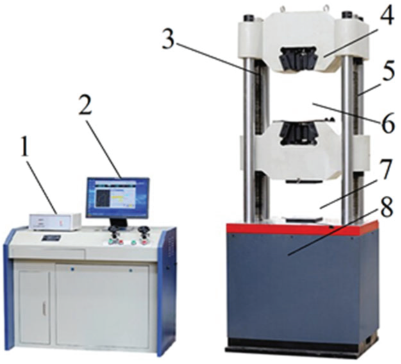


Fig. 2. General view of the universal testing machine WAW-1000D.

The recommended new design of steel gaskets is made using steel belts with inner and outer holes. To form these holes, circular belts of the ends of steel sheets in the form of tapes are welded. Therefore, it becomes necessary to conduct tensile tests.

State standards GOST 6996-66 - Welded joints. These standards determine mechanical properties of a welded joint as a whole and its individual sections, and the deposited metal in all types of welding of metals and their alloys [5]. A welded joint was used and static (short-term) tensile tests were conducted to determine the mechanical properties of steel belts.

However, to determine the practical stability of the recommended design of saw gasket, it is necessary to subject the steel belts to a tensile test.

To determine the tensile stability of steel (St3) belts between the saw blades of a linter machine, a WAW-1000D universal testing machine was used (Fig. 2) [6].

Universal testing machine WAW-1000D for tension and compression consists of 1 – control units; 2 - Maxtest software; 3 - traverses with a helical column; 4 - grippers (wedge clamps); 5 - 4-column load frame; 6 – test space for tension; 7 - test space for compression; 8 - oil cylinder (Figure 2).

Under clamping, the specimen under test should be positioned according to the clamp size range and the part that holds the specimen should be more than two-thirds of the clamp body (Figure 3).

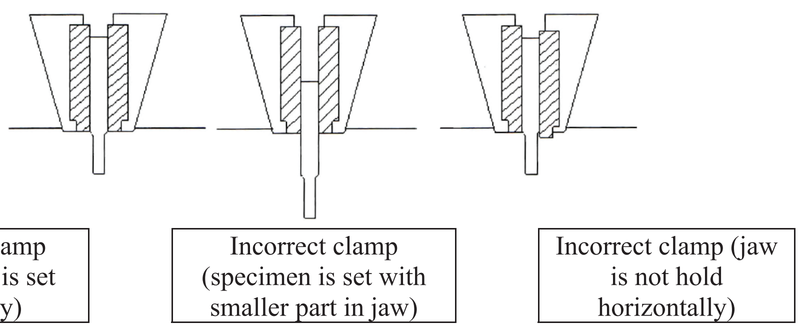


Fig. 3. Installation of samples during tensile testing.

2 Materials and methods

Basic requirements, methods and equipment set standards for testing samples to determine the characteristics of the mechanical properties and tensile strength of construction and other materials at a certain temperature [7].

The standard establishes a method for testing specimens to determine the mathematical relationship between stress and strain and to evaluate the ultimate strength. The mechanical characteristics defined using the standard can be used in the following cases [8]:

- selection of materials and justification of design solutions;
- acceptance inspection sampling of normalization of mechanical characteristics and evaluation of the quality of materials;
- development of technological processes and product design;
- calculations for the strength of structural elements.

Instruments and systems for measuring the deformations of materials must have an accuracy that allows one to perform a reliable analysis of the stress-strain state in the entire measurement range.

3 Results and discussion

The axial compression force of the saw blades when assembling the saw cylinder should not be less than N=20·10^3 N [2]. If we take the area of contact of the gasket of the linter machine 0.00209 m^2, then the stress is 9.567 MPa. At that, 159 saw gaskets were installed on the saw cylinder; the tightening force for one gasket was 125.786 N, and the stress was 0.06 MPa.

Further research was directed to finding the optimal welding method to assemble the steel gasket. The recommended design uses belts - the first for the outer diameter of the gasket, and the second for the inner diameter of the gasket to match the size of the saw cylinder shaft. To identify the necessary welding technology, electric arc welding (by the MMA method – with stick electrodes) and electric arc welding in a carbon dioxide (CO_2) medium – kemppi welding - were considered. To identify a rational welding technology, belts with a thickness of 1.5 mm and 2 mm were manufactured (Figure 4). For a tensile experimental study of gaskets (Figures 5-6), a universal testing machine WAW-1000D was used.

a)

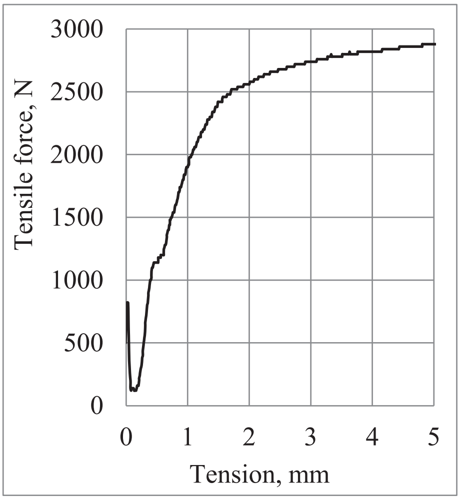
b)

Fig. 4. Samples of steel belts for the gaskets of a linter machine: a - before testing; b - after testing

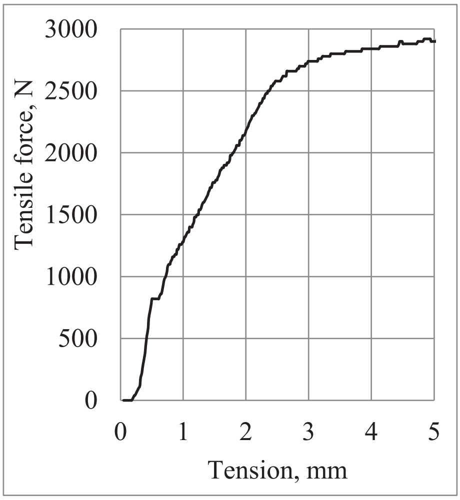
The tests of steel belts were conducted in accordance with the requirements of the experiment planning, and the mathematical processing of the test results was performed with a level of reliability (ρ=0.95) [9-14].

4 Conclusions

Analysis of the results of experimental studies of steel belts for the gaskets with a thickness of 1.5 mm and 2 mm (Figures 5-6) using electric arc welding and kemppi (carbon dioxide) showed that, for stretching up to 5 mm, 2820 N is necessary for a sample of 1, 5 mm for arc welding, and 2900 N for kemppi welding, and for a sample of 2 mm, 3260 N is necessary for arc welding and 4440 N for kemppi welding.



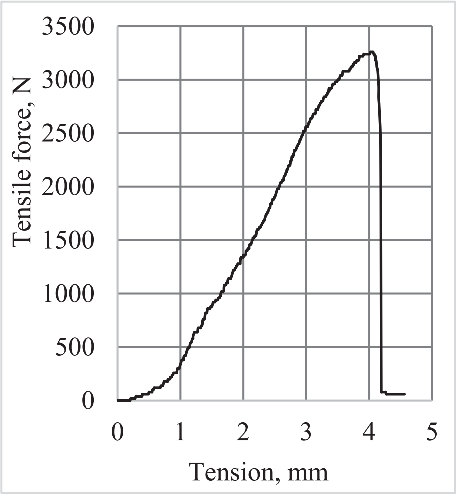
a)



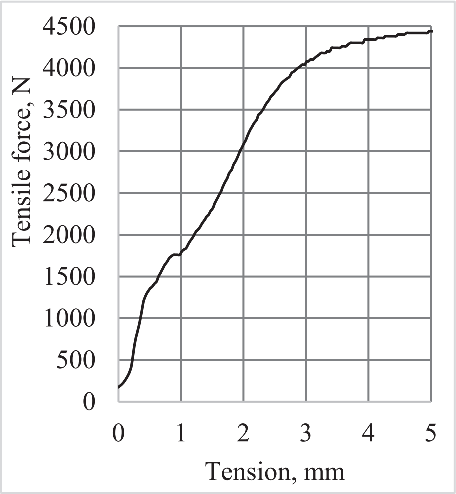
b)

a - electric arc; b - kemppi

Fig. 5. Tensile diagram of the steel belts St3 (with a thickness of 1.5 mm).



a)



b)

a - electric arc; b - kemppi

Fig. 6. Tensile diagram of the steel belt St3 (with a thickness of 2 mm).

The results of tensile testing of the belts allow them to be used in welding belts of steel gaskets, for electric arc and kemppi welding. The preference is given to the technology of welding belts of steel gaskets using an electric arc in a carbon dioxide (CO_2) medium - kemppi, since it provides the minimum thermal stress in the welding zone.

References

1. *Passport of saw linter 5LP* (TGSKB, Tashkent, 1981)

2. G. I. Miroshnichenko, *Fundamentals of designing machines for the primary processing of cotton* (Engineering, Moscow, 1972)
3. P. N. Tyutin, R. Yu. Melamedov, *The use of calibration in the manufacture of saw gin-linter gaskets*, (Cotton industry, Tashkent, 1975) **3**, 14-16
4. D. M. Mukhammadiev, F. Kh. Ibragimov et al., Pat. of the Republic of Uzbekistan No IAP 06691 appl. 12.29.2021 (2021)
5. GOST 6996-66, *Welded joints. Methods for determining mechanical properties,* (Moscow: Standartinform, 2006) https://www.directindustry.com.ru/prod/chengyu-testing-equipment-co-ltd/product-223988-2465268.html
6. GOST 1497-84, *Metals. Tensile test methods* (State Standard of the USSR, Moscow, 1986)
7. GOST 11701-84, *Metals. Tensile test methods for thin sheets and tapes* (State Standard of the USSR, Moscow, 1986)
8. Yu. P. Adler, E. V. Markova, Yu. V. Granovsky, *Planning an experiment in the search for optimal conditions* (Nauka, Moscow, 1976)
9. V. B. Tikhomirov, *Planning and analysis of the experiment* (Light industry, Moscow, 1974)
10. M. Augambaev, A. Z. Ivanov, Yu. T. Terekhov, *Fundamentals of planning a research experiment* (O'qituvchi, Tashkent, 1993)
11. I. V. Litvinova, V. B. Protas'ev, E. V. Plahotnikova, News of the Tula State University. Technical science **4**-**2**, 78-85 (2010)
12. Yu. A. Makarichev, Yu. N. Ivannikov, *Experiment planning and data processing methods* (SamGTU Publishing House, Samara, 2016)
13. D. M. Mukhammadiev, F. K. Ibragimov, O. K. Abzoirov, L. Y. Zhamolova, Modern Innovations, Systems and Technologies **2(4)**, 0301-0311 (2022). https://doi.org/10.47813/2782-2818-2022-2-4-0301-0311