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Department of aircraft design

APPROVED BY
Head of department
D.Sc., professor
__________S.R. Ignatovich
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MASTER THESIS
(EXPLANATORY NOTE)
EDUCATIONAL DEGREE
"MASTER"

THE EDUCATIONAL PROFESSIONAL PROGRAM
«AIRCRAFT EQUIPMENT»

Theme: « Justification of sealing profiles application on transport aviation aircraft »

Prepared by: _____________ **K.R. Maksimov**

Supervisor: D.Sc., professor _____________ **S.S. Yutskevych**

Consultants on separate chapters of the explanatory note:

labor protection:
Ph.d., associate professor _____________ **O.V. Konovalova**

environmental protection:
Ph.d., associate professor _____________ **L.I. Pavliukh**

Standart controller:
Ph.d., associate professor _____________ **S.V. Khiznyak**

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NATIONAL AVIATION UNIVERSITY

Aerospace Faculty
Department of aircraft design
Educational degree “Master”
Specialty 134 «Aviation and space rocket technology»
Educational professional program «Aircraft equipment»

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____________S.R. Ignatovych
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TASK
for the master thesis

MAKSYMOV KYRYLL

1. Theme: **«**Justification of sealing profiles application on transport aviation aircrafts**»**, approved by Rector’s order № 1906/ст from October 5, 2020.
2. Period of work execution: from October 5, 2020 to December 13, 2020.
3. Initial data: sealing profiles of fuselage mechanization, sealants, hydraulic press FM-250.
4. Content (list of topics to be developed): analysis of the problem, methodology, experiment data, analysis of harmful and dangerous production factors, environmental impact analysis.
5. Required materials: general view of an aircraft with sealing profiles installation location (A1x1); graphs with experimental data illustration (A3x5).

6. Thesis schedule

Task	Execution period	Signature
Task receiving, processing of statistical data.	5.10.2020- 9.10.2020	
Methods and procedures.	12.10.2020 - 16.10.2020	
Analysis of the material properties.	19.10.2020 –23.10.2020	
Experiments.	26.10.2020 – 13.11.2020	
Analysis of the data.	16.11.2020 – 20.11.2020	
Labor protection .	23.11.2020 – 27.11.2020	
Environmental protection.	27.11.2020 – 30.11.2020	
Complection of the explanation note.	30.11.2020 – 5.12.2020	

7. Special chapters consultants

Chapter	Consultant	Data, signature	
		Task issued	Task received
Labor protection	PhD, associate professor O.V. Konovalova		
Environmental protection	PhD, associate professor L.I. Pavliukh		

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Thesis supervisor ____________ S.S. Yutskevych

The task was accepted for execution: ____________ K.R. Maksymov

ABSTRACT

Master degree thesis “Justification of sealing profiles application on transport aviation aircrafts”

65 p., 19 fig., 3 tables, 5 references

Object of study is a sealing profiles used for an aircraft pressurization.

Subject of study is determination of fuselage sealing profiles characteristics for rapture, tension, compression ratio and friction.

Aim of master thesis is to solve the problem of choosing necessary type of sealing profiles and their fastening method to provide safety and needed operational conditions.

Research and development methods – the research was carried out using special equipment for a hydraulic press, a dynamometer and various measuring devices to ensure accurate indicators and research results.

Novelty of the results demonstrate the strength and mechanical characteristics of the new sealing profiles developed for this aircraft model.

Practical value is obtaining the necessary data that demonstrates the performance of sealing profiles and directly affects the safety of the flight and ensuring optimal operating conditions.

The results of the work can be implemented in the selection of sealing profiles required for the mechanization of the fuselage to ensure optimal performance of pressurization.

AIRCRAFT, SEALING PROFILES, FUSELAGE, MECHANIZATION, STRENGHTS ANALYSES.

CONTENT

ABBREVIATIONS

FM – Fuselage mechanization;

MC – Mechanical characteristics;

MP – Mechanical properties;

SC – Strengths characteristics;

SP – Sealing profile;

TM – Test measures;

INTRODUCION

Sealing of the fuselage, especially in passenger aircraft, is very important because sound insulation, thermal insulation, and even fuel consumption depend on its quality. Due to incomplete or poor-quality sealing at high altitudes, the air conditioning system will consume a large amount of energy, which affects fuel consumption, which in the long run can lead to significant economic losses for the airline.

Sealing profiles are related to the sealing of doors, hatches and compartments of vehicles that can be used in aircraft construction and other places. Sealing is an important structural element of any type of product that is acting with liquid and operate at high altitudes with the necessity of providing optimal conditions for the life support of the crew or pilot. So, for example, in transport aviation, this effects on the air quality in the cabin, which is a key factor, because the aircraft can operate at an altitude of more than 10 kilometers. The sound insulation factor also depends largely on the quality of the connection and the tightness of the profile with the housing. Also, in military transport aviation, sealing must comply with all the above standards to ensure the crew, landing and specific cargoes with optimal living conditions.

Therefore, manufacturers and experienced design bureaus are engaged in a detailed study of the sealing scheme for critical structural elements. In view of the foregoing, their task is to ensure the stable performance of their functions in a wide range of plus and minus temperatures.

In this work, it will be considering the problems of using fuselage mechanization sealing profiles on Antonov aircrafts. Under the mechanization of the fuselage, it is customary to understand all doors, hatches and sashes that apply to any sections of the fuselage. The analysis is carried out on testing equipment and test stands. Based on the taken data, I will make an individual approach and methodology for the test and approach to its analysis.

Indicators of the mechanical properties of the sealing profiles used in fuselage mechanization were determined. During the experiments, it was determined what indicators the tested main sample G4 demonstrated and whether it satisfy the operating conditions in which the profile will be after installation.

1 FEATURES OF SEALING PROFILES EXPLOITATION AND TESTING

1.1 Analysis of application

Specialized airframe products like airframe seals are not only used within fuselage mechanization sealing but throughout the engine compartment, the aircraft body, on wings, windows and doors, where they contribute to aerodynamic efficiency. Focusing on aerodynamic efficiency, they offer reliability in service, along with efficiency in assembly and maintenance. The use of advanced technologies combined with product qualification programs, including extensive testing and verification, leads to maximum service life.

Sealing solutions of airframe seals, from existing tooling where possible, are used within the engine, structural gaps, wings, doors, hatches, and windows to meet customer needs throughout the aircraft. Sealing solutions design capabilities can also address applications for wing and moving surfaces including complex aerodynamic shrouds for hydraulic jacks, extrusions and fabricated seals for doors and hatches, and interior couplings. Complex and even inflatable geometries can be developed for specific applications.

The main sources of information that provide publicly available data regarding the experience of use and recommendations for the operation of sealing profiles for doors, sashes and hatches are the documentation of the latest revisions from the MSG-3 manuals.

The standards of quality and reliability for the sealing profiles of the mechanization of the fuselage are determined by their durability during use, the number of defects detected during operation, as well as the frequency of replacement and mandatory maintenance during inspections, both visual and scheduled, using non-destructive methods of inspection, flaw detection. In a scheduled inspection, non-destructive testing methods provide the following options:

- the ability to control at all stages of manufacture, during operation and during repair of products;
- the ability to control the quality of the profile for most of the specified parameters;
- high reliability of control results;

- high reliability of flaw detection equipment and the possibility of using it in various conditions.

It will be considering the problems of using fuselage mechanization sealing profiles on Antonov aircrafts. Under the mechanization of the fuselage, it is customary to understand all doors and hatches that apply to any sections of the fuselage figure 1.

Cutouts for doors, windows, lights, hatches, landing gear niches violate the closed contour of the fuselage shell and reduce its torsional and bending stiffness and strength. You can compensate for these losses by creating a fairly rigid frame border around the cutout. With small dimensions of the cutout, such a border is created in the form of a monolithic structure obtained by stamping from a sheet or other manufacturing methods.

Large cuts are edged at the ends by reinforced frames, and in the longitudinal direction by reinforced spars or beams, which should not end at the borders of the cut, but continue beyond reinforced frames, providing a tight seal of these longitudinal elements.

All such cutouts for fuselage mechanization like doors, hatches and ramps also violate the sealing of the cabin in the absence of special sealing profiles. So, we can see that in the presence of such a high number of necessary cutouts for mechanization, designers must provide optimal conditions inside the aircraft. For this, they resort to the use of sealing profiles of various shapes and sections.

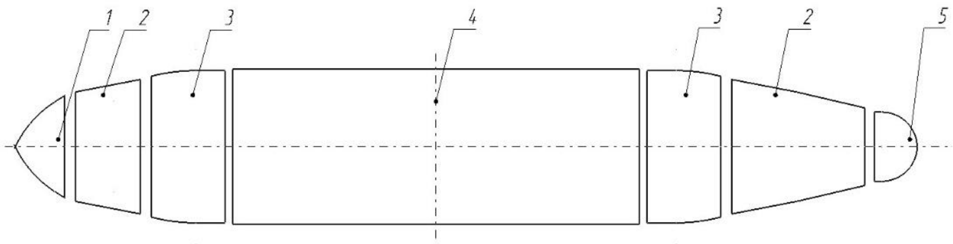

Figure 1.1 - Fuselage sections

1, 5 - hemispherical surfaces, 2 - conical,

3 - double curvature, 4 - cylindrical.

1.2 Analysis of the necessary material properties

The choice of optimal materials and additional equipment profile is a priority for designers. Previously, sealing profiles were made entirely of rubber - an elastic material obtained by vulcanization of natural rubber. Nowadays, with the development of technology, profiles made of silicone are widely used.

Practice shows that in order to provide better cooling, ventilated and temperature removal, it is preferable to install silicone profiles. They are very different from rubber. The latter break and harden after only several years of operation. Silicone, on the other hand, is durable and has a long service life. Compared to rubber, they are called durable.

Rubber tends to become obsolete quickly. And its application in the system is not the best option. Wear of rubber is manifested in its cracking, breakage, hardening. Rubber will not be able to withstand temperature changes due to its composition. They are necessary for me quite often, especially in operating conditions with frequent temperature drops literally in one flight.

Particularly spoil the air pipes circulating in them. The reason for this is pressure. This can lead to malfunctions and cracking. If they are visually visible from the outside, this indicates that the replacement of the nozzle is needed immediately. A routine inspection helps to identify cracks inside the nozzles.

To choose the right silicone product, you need to identify all the parameters of the work, from the pressure that will pass through them to the mold. If you use reinforced frames for silicone profiles, this will increase the stiffness and strength, which will help reduce the impact of operational loads.

A similar form of silicone pipes with the original rubber helps to ensure the correct operation of any system. If there are differences, then the parameters specified by the manufacturer at the time of the release of the unit will be violated. The resource of silicone parts will be high, which will pay off the invested money for the rubber product itself. By installing silicone nozzles, you can significantly reduce operating costs.

Comparing these two materials, a more reliable and durable material is selected that is more resistant to stress during operation. For safety and significant ease of control, silicone products are procured.

Silicone pipes are rubber products that do not expand under excessive pressure and withstand even its high performance.

The use of silicone connectors makes it easy to connect to each other. The universality of the use of such profiles in this case is undeniable. Only thanks to them can the entire system of the aircraft be ensured at the most efficient level. Therefore, selecting the profiles made of silicone correctly, based on the diameter of the channels, you can ensure high-quality work, and at the same time high safety and reliability indicators.

When choosing forms of profiles made of silicone, you should pay attention to system configurations. You can find bent pipes, the angle of which will be straight. Universal internal diameters allow their use on different elements of the mechanization of the fuselage. This adds another advantage. Multilayer silicone, will help not to pass the heat and liquid. This also happens due to the following facts: reinforcement and multilayer polyester knitwear. As a result, a thick tube, characterized by elasticity, will prevent the ingress of liquid and air admission and resist the influence of increased or decreased temperature.

Advantages of silicone profiles:

- full compliance of the declared characteristics with respect to what happens in real operating conditions, especially when the temperature changes;
- high indicators of durability of a rubber product, which directly affects low operating costs and the frequency of repairs;
- flexibility and softness of the product material, which directly affects the high resistance to all deformation processes under compression;
- the possibility of their use as the main elements of the sealing of the fuselage;
- application in any position, as long as the diameter of the product is suitable, which is facilitated by the absence of influence on them of temperature, aggressiveness of the environment, and the composition of different substances;
- compact collection of various forms when using silicone profiles, which is greatly helped by the presence of rubber products of different lengths and shapes.

There are not only universal silicone profiles that can be applied based on their volume and diameter, but also those that have a certain form of bending. In both the first and second, it is best to select silicone profiles similar to the rubber prototype that was in the system initially. Although, one should not forget that the main properties of silicone are the durability, elasticity and flexibility of the material.

The conclusion can be made such that silicone tubes, unlike rubber, are unique and even universal products. Given their wear-resistant properties, resistance to temperatures, both high and low, flexibility and durability, not prone to cracking and mechanical damage, reinforcement and all the ensuing consequences, this has a positive effect on the life of the motorist himself. The main result is a significant relief of the tasks that are involved in caring for your own car, especially thanks to the release in different or universal forms.

1.3 Test analysis

This example of developing a test methodology and approach to its implementation is purely individual for solving this particular problem and is developed by a design engineer based on his vision of the need to obtain certain data on the mechanical properties of samples.

The evolution of the analysis is carried out by updating the testing equipment and test stands, as well as improving and modernizing the equipment. Based on the above data, the engineer makes a decision and develops an individual approach and methodology for the test and approach to its analysis. Tests of sealing profiles in aviation are relatively typical and for this type of research samples are standard procedures for determining the mechanical properties of sealing profiles such as:

- tensile strength;
- compression force;
- frictional properties;
- adhesive properties;
- thermal tests.

Before use, any new material must pass a series of tests, including a mechanical tensile test. During the tensile test, it is possible to determine the tensile strength of the fuselage sealing profile. These indicators are important in that at constant loads, overpressure and a sharp change in the temperature range during operation, the sealing profile is constantly exposed to loads that lead to a change in its geometric parameters, including lengths. A break in the sealing profile can lead to partial depressurization of the aircraft, which can subsequently affect hypoxia in passengers and crew. Such problems are a direct threat to flight safety, as a result of which it is necessary to test the sealing profiles in order to make sure that the specified operational loads multiplied by the safety factor will comply with all standards and ensure flight safety.

Including the important parameters necessary for the stable and proper operation of the sealing profiles, compression testing of the profile also applies. This test simulates the profile in the closed position of doors, hatches and sashes. This is necessary to determine how strong the deformation of the sample will be when applying forces perpendicular to its upper part as a result of simulating the work of mechanization. So, if the compression is insufficient, complete sealing cannot be ensured, at the same time, not excessive forces can lead to mechanical damage to the profile or again to loss of contact of the sealing profile with the surface, which will lead to the consequences described above.

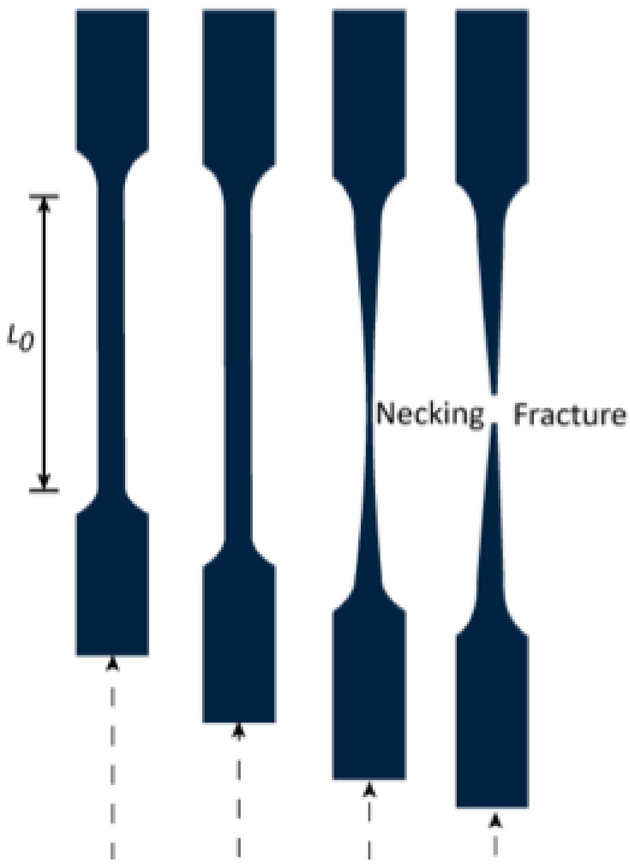

Figure 1.2 - Determination of sealing profile rapture parameter

The frictional properties of the material are characterized by relative displacement and wear resistance. Friction is distinguished: motionless, moving, sliding, rolling, dry friction, boundary (that is, in the presence of a thin lubricating film) and liquid, or hydrodynamic (that is, there is a liquid layer between the friction surfaces). According to their physicochemical properties, wear is divided into mechanical, molecular-mechanical, corrosion-mechanical, abrasive, hydroabrasive, gaseous, fatigue, erosion, wear during cavitation, oxidation, firing and fretting. The body is applied to the contact area during the test. Its value depends on the material of the rubbing body (frictional compatibility), the roughness of the friction surface, lubrication conditions, and other physicochemical properties. In our case, we are interested in friction moving and dry, as well as fatigue wear.

The test is an imitation of the profile by pulling it through a structure similar to the one in which it will be installed later. In this way, friction is checked and the necessary surface roughness of the profile installation is determined to ensure that its movement is limited in case of loss of stability. It is also worth noting that usually the profile is fixed using different sealants which also have different properties and characteristics, this will be discussed later. In this case, the tests simulate the complete or partial erasure of the sealant, which should ensure the immobility of the sealing profile around the perimeter of its installation.

Another important part of sealing profile are sealants which provide the sample fixing on the surface of the fuselage mechanization. Assembly. So, to ensure the required profile characteristics, you must also select the correct sealant. For this purpose, sealants are also tested. These tests include the determination of tensile forces, which helps us determine the ultimate forces in which the sealing profile of a limited area can function without loss of stability. In addition to everything, it is necessary to determine the best sealant that will be used in future in serial production. The necessary and important parameters of the sealants, in addition to the peeling force, are their adhesive properties both in relation to the sealing profile and to the fixing surface. This parameter affects the performance and manufacturability, since residual sealant on the surface leads to a waste of time on cleaning the surface when installing and replacing new profiles.

Temperature (thermal tests) make it possible to determine the ability of the sealing profile to provide the necessary parameters of functionality, as well as the stable operation of the structure when the temperature changes (it decreases) in the future operating environment, this temperature indicator can reach -60 °C. At such low temperatures, the materials lose their elasticity and ductility, which can lead to mechanical damage to the sealing profiles. Thus, this parameter also directly affects the safety of the aircraft and must be determined [1].

In the future, difficulties may arise with the study and methodology of the approach to testing sealing profiles associated mainly with the development and development of new materials for their manufacture, thus we obtain samples of sealing profiles with altered mechanical characteristics and improved properties. Thus, with increasing standards, the approach to determining the quality of products and their wear resistance in aspects of operation and other things will change. Therefore, it is considered necessary to monitor new developments and innovations in the world regarding the chosen research topic. These actions contribute to the phased timely introduction of new technologies in production and development in order to obtain high-quality goods and a high reputation in the field of activity.

In connection with the termination of the supply of imported sealing profiles due to political inconsistencies, a decision was made to replace samples of the previous type with sealing profiles manufactured in-house for further continued operation and production. It was experimentally established that domestic companies cannot cope with the high requirements of aviation and cannot provide an alternative. Thus, it was decided to use the Hutchinson company, which has extensive experience in manufacturing such samples of sealing profiles for medium-haul civil aviation aircraft and works with Airbus. So, after a trial order was completed, prototypes of sealing profiles were obtained for further research and testing conducted in this work.

1.4 Analysis of alternative developments

The present invention relates to the sealing of doors, covers, casement hatches and vehicle compartments and can be used in aircraft, shipbuilding and so on.

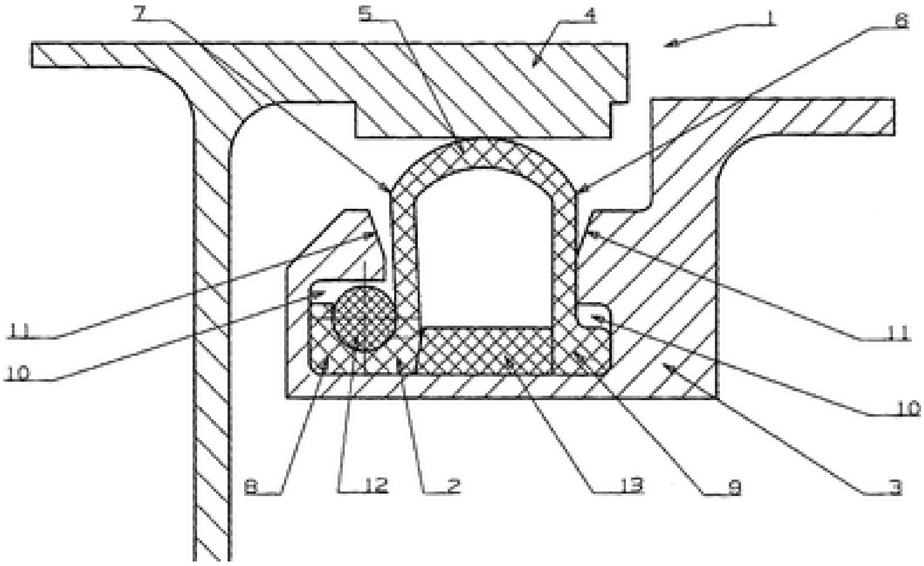

Figure 1.3 - Cross section of sealing profile prototype

Known sealing devices contain a closed sealing profile (inflatable hoses), mounted on the edging, and a cover. Sealing is ensured by the force of pressing the cover and applying pressure to the internal cavity of the sealing profile. Fixation of the sealing profile on the edging is mainly adhesive. To form a tight contour, its ends are glued with inserts.

The disadvantages of such devices are:

- dependence of the degree of tightness on the force of pressing the closed sealing profile to the edging or pressure inside the sealing profile;
- high laboriousness of work during installation and dismantling of a closed sealing profile, as adhesive joints;
- complex joining of parts of closed sealing profiles - the use of docking parts and laborious bonding;
- low manufacturability and high cost of manufacturing the most closed sealing profile and tooling for manufacturing.

A sealing device is known comprising a sealing profile with petals, a fringing for attaching it and a cover. Sealing is provided by pressing the petals from the side of the overpressure to the counterpart (cover or edging). Installation is carried out by gluing or if the profile of the pressurization of the legs is riveted with soft rivets. Dismantling is carried out by tearing off the sealing profile from the edging during adhesive bonding or drilling rivets during rivet bonding. The sealing profile with the petals is made whole along the entire sealing loop.

The disadvantages of this sealing device are:

- vulnerability from mechanical damage to the petals of the sealing profile;
- low manufacturability during installation and dismantling of the sealing profile, as adhesive and riveted joints require preparation of surfaces for joining;
- low manufacturability of manufacturing a sealing profile with petals, as the sealing profile with the petals must be closed around the perimeter of the opening or hatch.

Closest to the proposed invention is a sealing device containing a hollow elastic sealing profile installed in the cavity of the edging groove, to hold the elastic sealing profile, it is glued to the cavity of the edging groove. Sealing is ensured by the force of pressing the cover against the sealing profile, as well as by the fact that the edging chute holds the sealing profile from local deformations and ensures its deformation of a given shape, while the gap between the edging chute and the cover plane serves as compensation for maintaining the internal volume of the sealing profile. Disadvantages of such construction:

- dependence of the degree of tightness on the force of pressing the closed sealing profile to the edging or pressure inside the sealing profile;
- the complexity of manufacturing a closed sealing profile;
- low manufacturability during installation and dismantling of the sealing profile by gluing edging into the gutter;
- low adaptability of joining the ends of a closed sealing profile;
- in the place where the gap is formed, increased wear of the sealing profile is observed between the lid and the edging groove, as in these places it bends to small radii along the entire sealing loop.

The objective of the invention is to ensure tightness through the use of a U-shaped sealing profile, as more technologically advanced, simplifying the installation and dismantling of the sealing profile from the edging chute, ensuring the tightness of the joints of the ends of the sealing profile.

The technical result is achieved by the fact that the sealing device contains a sealing profile, which is made U-shaped with a convex upper part of variable stiffness, bounded by two ribs, and equipped with two legs formed at the junction of the convex upper part with legs, fixed in the edging groove, made with two grooves for the legs and two expanding compensation bevels using fixing elements of an elastic spacer plate and cord, while the ends of the sealing profile are pointed and, when mated with each other, form an inclined plane of the joint, ensuring tightness of the closed loop.

The sealing device 1 includes a sealing profile 2, a fringing groove 3 and a cover 4. The sealing profile 2 is made U-shaped, with a convex upper part 5 of variable stiffness (thickness) bounded by two ribs 6 and 7, at the junction of the convex upper part 5 with tabs 8 and 9. The tab 8 is made with a groove. The edging groove 3 is made in the form of a profile with grooves 10 under the tabs 8 and 9 and with expanding bevels 11, which, when deforming the sealing profile 2, allow its internal volume to be compensated so that there is no need to bypass the air inside the internal volume of the sealing profile 2 A sealing profile 2 is located in the cavity of the edging groove 3, and tabs 8 and 9 are inserted into the grooves 10. The sealing profile 2 is fixed in the edging groove 3 using fixing elements — an elastic cord 12 securing the tab 8 and a spacer plate 13 that bursts (holding) tabs 8 and 9 in the grooves 10 of the edging groove 3. The cover 4 is made with a flat surface adjacent to the sealing profile 2.

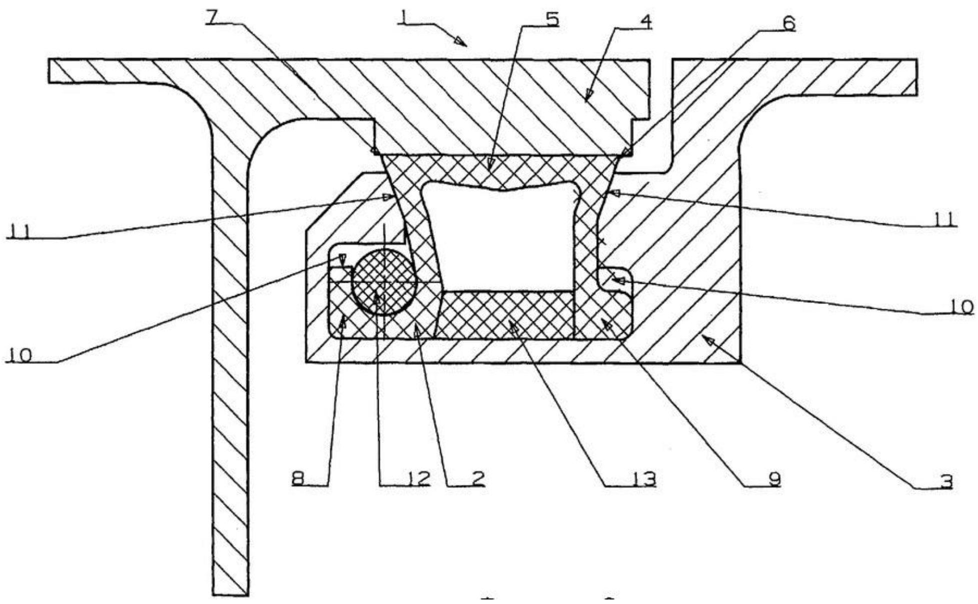

Figure 1.4 - Cross section of sealing profile prototype

Installation of the sealing profile 2 is carried out as follows: a spacer plate 13 is inserted inside the sealing profile 2. The tabs 8 and 9 are bent, clamping the spacer plate 13, and the sealing profile 2 is inserted into the cavity of the edging groove 3. The tabs 8 and 9 are unbent, go into grooves 10 and the spacer plate 13 freely moves to its lowest position inside the sealing profile 2, fixing the tabs 8 and 9 in the grooves 10 of the edging groove 3. To install the fixing cord 12, the tab 8 and the upper convex part 5 of the sealing profile 2 are bent and through the gap formed between the sealing profile 2 and the groove of the fringing 3 into the groove 10, with effort and a slight deformation in diameter, a fixing cord 12 is inserted, holding the tab 8 into the groove 10 and the spacer plate 13 in the lowermost position, preventing it from moving inside the sealing profile 2. Sealing profile 2, fixing cord 12 and the spacer plate 13 can be closed around the entire perimeter of the seal, but can consist of parts of any length. At the same time, the ends of the parts of the sealing profile 2 are made pointed (for example, 30-70 degrees to the sides) and, when mating, the ends form an inclined plane of the joint (such as the “on the mustache” joint), without the use of adhesive materials, and the joints of the fixing cord 12 and the spacer plate 13 can be performed both end-to-end and with a gap not exceeding, for example, the thickness of the spacer plate 13 or the diameter of the fixing cord 12. Dismantling is carried out in the reverse order.

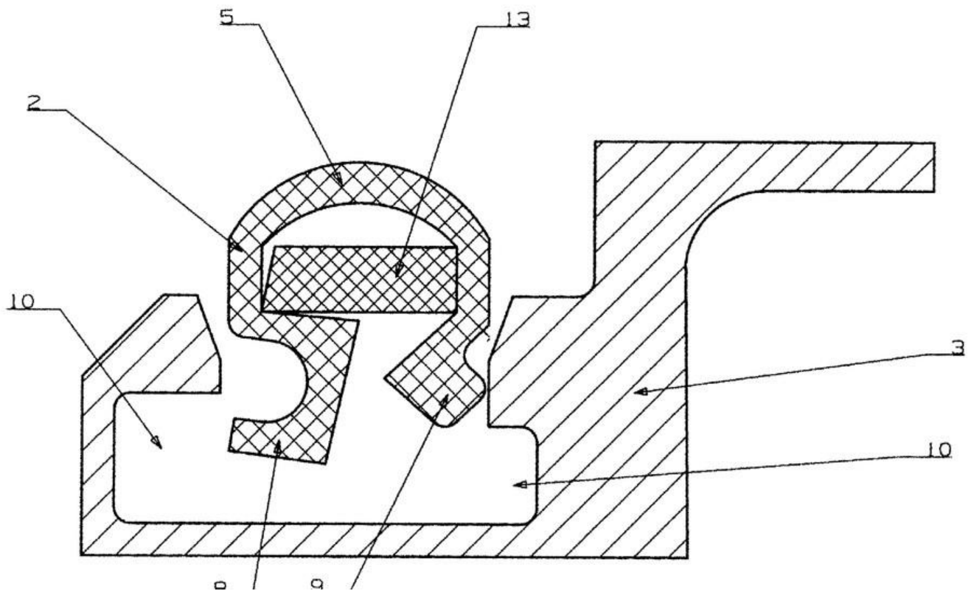

Figure 1.5 - Cross section of sealing profile prototype

The operation of the sealing device 1 is as follows. When closing, the cover 4 with its plane deforms the upper convex part 5 of the sealing profile 2. In this case, the tabs 8 and 9 are bent in opposite directions and pressed against the bevels 11 of the groove of the edging 3, deforming, the upper convex part 5 of the sealing profile 2 together with the tabs 8 and 9 form two "wedges" resting on the lid 4 and on the bevels 11 of the edging groove 3. The thickening of the upper convex part 5 prevents it from falling inside the sealing profile 2. When the external pressure exerts pressure on the sealing profile 2, the opposite side of the sealing profile 2 is pressed - the upper convex part 5 - to the cover 4, and, respectively, the tabs 8 or 9 to one of the bevels 11 of the edging groove 3, then, respectively, the rib 6 or 7 enters the gap between the cover 4 and the edging groove 3. The stronger the external overpressure acting on the sealing profile 2, the stronger the wedge is pressed against the cover 4 and the corresponding bevel 11.

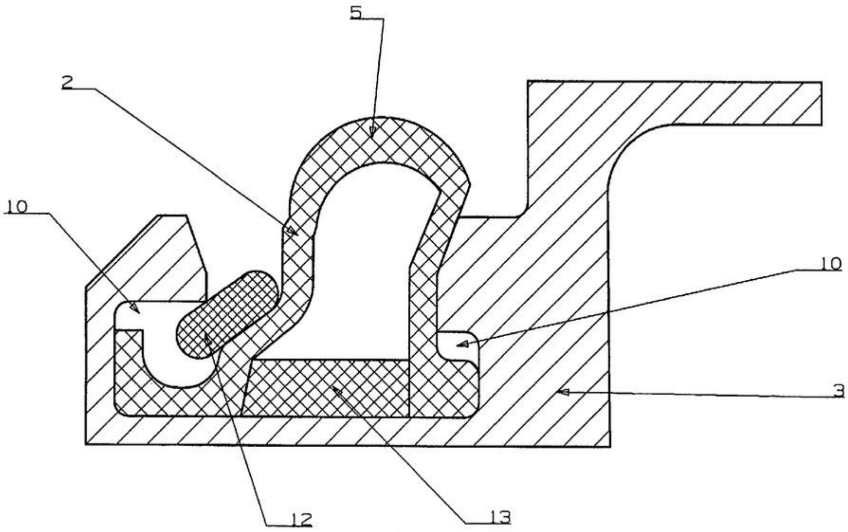

Figure 1.6 - Cross section of sealing profile prototype

The tightness of the junction of the parts of the sealing profile is ensured by the inclination of the joint plane to the vector of the effective pressure and the absence of a gap between them, which allows the surface of the joint of one part of the sealing profile 2 to be pressed tightly against the joint surface of the other part.

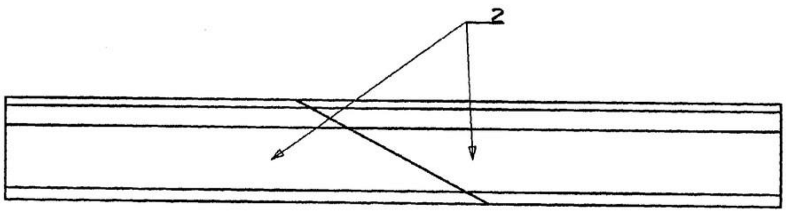

Figure 1.7 - Sample

Using the proposed design allows to achieve a high degree of tightness due to deformation of the sealing profile (pressing a “wedge” into the gap between the edging groove 3 and the cover 4), production and operational manufacturability due to the fact that a U-shaped sealing profile is used, which is fixed in the edging groove elastic spacer plate and cord, to ensure the tightness of the joint without gluing the ends of the sealing profile due to the inclination of the joint plane [2].

A sealing device comprising a sealing profile with a convex upper part, fixed in the edging chute, and a cover, characterized in that the sealing profile is made U-shaped with a convex upper part of variable thickness, limited by two ribs, provided with two tabs and secured with fixing elements, made in the form of a spacer plate and cord, in a fringing chute made with two grooves for paws and two compensation bevels, while the ends of the sealing profile are pointed and, when mated with each other, form an inclined plane of the joint, ensuring tightness of the closed loop.

CONCLUSION TO PART 1

Sealing the mechanization of the fuselage is a very important part of the design, ensuring flight safety, as well as the proper operation of all aircraft systems. A complete and accurate analysis of the design and installation of the seal must be carried out with high accuracy and responsibility. The engineering team should conduct research on prototypes and analyze the experience of using previous and existing models, draw the necessary conclusions and develop or choose the most optimal design option. Carry out the necessary tests, make an analysis and provide a suitable design for operation that meets safety standards and is able to work in a wide range of operating loads.

2 METHODS AND TOOLS OF FUSELAGE MEACHANIZATION SEALING PROFILES EXPERIMENTAL RESEARCH

The developing a test methodology and approach to its implementation is purely individual for solving this particular problem and is developed by a design engineer based on his vision of the need to obtain certain data on the mechanical properties of samples.

The evolution of the analysis is carried out by updating the testing equipment and test stands, as well as improving and modernizing the equipment. Based on the above data, the engineer makes a decision and develops an individual approach and methodology for the test and approach to its analysis. Tests of sealing profiles in aviation are relatively typical and for this type of research samples are standard procedures for determining the mechanical properties of sealing profiles such as:

- tensile strength;
- compression force;
- frictional properties;
- adhesive properties;
- thermal tests.

Before use, any new material must pass a series of tests, including a mechanical tensile test. During the tensile test, it is possible to determine the tensile strength of the fuselage sealing profile. These indicators are important in that at constant loads, overpressure and a sharp change in the temperature range during operation, the sealing profile is constantly exposed to loads that lead to a change in its geometric parameters, including lengths. A break in the sealing profile can lead to partial depressurization of the aircraft, which can subsequently affect hypoxia in passengers and crew. Such problems are a direct threat to flight safety, as a result of which it is necessary to test the sealing profiles in order to make sure that the specified operational loads multiplied by the safety factor will comply with all standards and ensure flight safety.

Including the important parameters necessary for the stable and proper operation of the sealing profiles, compression testing of the profile also applies. This test simulates the profile in the closed position of doors, hatches and sashes. This is necessary to determine how strong the deformation of the sample will be when applying forces perpendicular to its upper part as a result of simulating the work of mechanization. So, if the compression is insufficient, complete sealing cannot be ensured, at the same time, not excessive forces can lead to mechanical damage to the profile or again to loss of contact of the sealing profile with the surface, which will lead to the consequences described above.

In order to determine the elasticity properties at compression and tension of the material from which the sealing profile is made, it is necessary to use special equipment. Providing of this test is carried out on hydraulic press, which help us to determine the parameter of pressure loading necessary for providing pressurization of fuselage and its mechanization at high quality level.

Figure 2.1 - Hydraulic press and sealing profile at testing.

The frictional properties of the material are characterized by relative displacement and wear resistance. Friction is distinguished: motionless, moving, sliding, rolling, dry friction, boundary (that is, in the presence of a thin lubricating film) and liquid, or hydrodynamic (that is, there is a liquid layer between the friction surfaces). According to their physicochemical properties, wear is divided into mechanical, molecular-mechanical, corrosion-mechanical, abrasive, hydro-abrasive, gaseous, fatigue, erosion, wear during cavitation, oxidation, firing and fretting. The body is applied to the contact area during the test. Its value depends on the material of the rubbing body (frictional compatibility), the roughness of the friction surface, lubrication conditions, and other physicochemical properties. In our case, we are interested in friction moving and dry, as well as fatigue wear. The test is an imitation of the profile by pulling it through a structure similar to the one in which it will be installed later. In this way, friction is checked and the necessary surface roughness of the profile installation is determined to ensure that its movement is limited in case of loss of stability. It is also worth noting that usually the profile is fixed using different sealants which also have different properties and characteristics, this will be discussed later. In this case, the tests simulate the complete or partial erasure of the sealant, which should ensure the immobility of the sealing profile around the perimeter of its installation.

To determine the frictional properties that determine the density of the clamp profile with the necessary force in a given range of distance tests are carried out by pulling the sealing profile through the simulated installation site. The parameters and results we can get with the help of dynamometer.

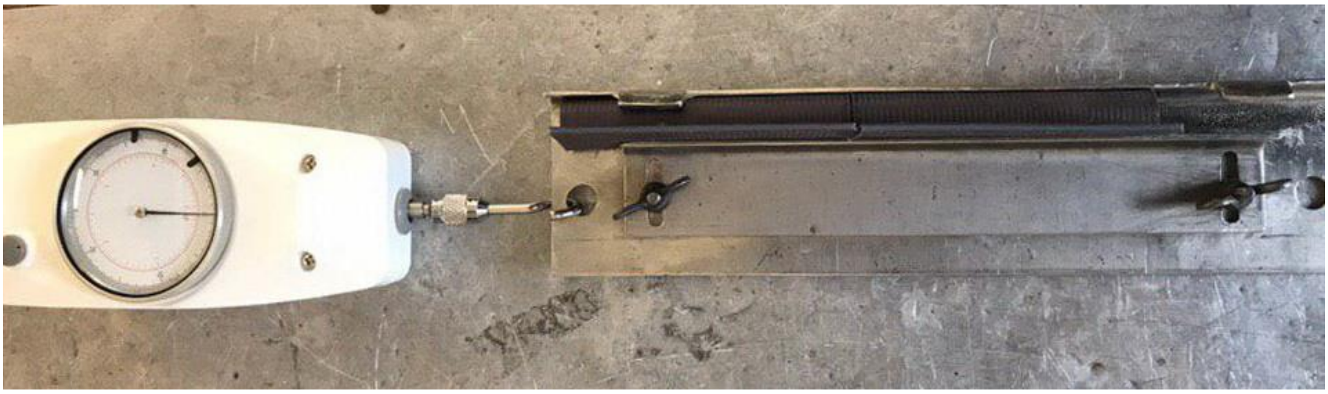

Figure 2.2 - Dynamometer at testing

Sealants are also tested. These tests include the determination of tensile forces, which helps us determine the ultimate forces in which the sealing profile of a limited area can function without loss of stability. In addition to everything, it is necessary to determine the best sealant that will be used in future in serial production. The necessary and important parameters of the sealants, in addition to the peeling force, are their adhesive properties both in relation to the sealing profile and to the fixing surface. This parameter affects the performance and manufacturability, since residual sealant on the surface leads to a waste of time on cleaning the surface when installing and replacing new profiles.

Temperature (thermal tests) make it possible to determine the ability of the sealing profile to provide the necessary parameters of functionality, as well as the stable operation of the structure when the temperature changes (it decreases) in the future operating environment, this temperature indicator can reach -60 °C. At such low temperatures, the materials lose their elasticity and ductility, which can lead to mechanical damage to the sealing profiles. Thus, this parameter also directly affects the safety of the aircraft and must be determined.

Figure 2.3 - Sealing profiles at thermal testing

In the future, difficulties may arise with the study and methodology of the approach to testing sealing profiles associated mainly with the development and development of new materials for their manufacture, thus we obtain samples of sealing profiles with altered mechanical characteristics and improved properties. Thus, with increasing standards, the approach to determining the quality of products and their wear resistance in aspects of operation and other things will change. Therefore, it is considered necessary to monitor new developments and innovations in the world regarding the chosen research topic. These actions contribute to the phased timely introduction of new technologies in production and development in order to obtain high-quality goods and a high reputation in the field of activity.

In connection with the termination of the supply of imported sealing profiles due to political inconsistencies, a decision was made to replace samples of the previous type with sealing profiles manufactured in-house for further continued operation and production. It was experimentally established that domestic companies cannot cope with the high requirements of aviation and cannot provide an alternative. Thus, it was decided to use the Hutchinson company, which has extensive experience in manufacturing such samples of sealing profiles for medium-haul civil aviation aircraft and works with Airbus. So, after a trial order was completed, prototypes of sealing profiles were obtained for further research and testing conducted in this work.

In this study, determining the mechanical and adhesive properties of sealing profiles, the quality indicator is the compliance of the profiles with the calculated loads and safety factor to ensure flight safety. So, the profiles during the tests confirmed their specifications declared by the manufacturer and demonstrated preliminary operational properties. The efficiency of using this type of specimen is due to maintainability and economic benefit, which is derived from the speed of maintenance of this type of specimen sealing profiles. In this case, the key point was the tests of sealants with the help of which the profiles were fixed on the plates with chemical examination and other types of processing. Most preferred are sealants that exhibit high adhesive properties with a profile, which means that most of the sealant, when disconnected, remains on the sealing profile, thereby freeing maintenance personnel from prolonged surface cleaning when replacing sealing profiles

Improving the development of determining the quality of samples is associated with improving the equipment for testing, improving and modernizing laboratory stands, as well as by attracting experienced specialists (which minimizes the influence of the human factor on the process. Also, improving the accuracy of measuring instruments and computerization of processes will lead to an improvement in the quality of determination of mechanical properties sealing profiles.

A method for determining the conformity of an object to a task is its compliance with a given design load, which was calculated based on experience and estimated loads on the structure in operation, taking into account the safety factor. So, during the tests, the required parameters and properties were established, which gives us the opportunity to present the behavior of the test object during operation and give an assessment determining the possibility of using this development in An-series aircraft.

CONCLUSION TO PART 2

The tests of the mechanical properties of sealing profiles described above (tensile tests, frictional and elastic properties) are key for this type of object under study. Tensile tests are important in view of the fact that the sealing profile cannot be integral due to the design features of the mechanization circuit of the working object and it contains joints that are connected by gluing, an amplifier and a bougie to ensure the integrity of the profile contour. So, the profile must withstand the required design tensile strength. To determine these properties.

3 RESULTS OF FUSELAGE MECHANIZATION SEALING PROFILES RESEARCH

The object of laboratory testing is the joint of sealing profiles. Samples are two parts joined according to technical recommendations and technical instructions on DOWCORNING sealant. The profile sections are a tube with a mounting shelf and are made of B452 silicone rubber, reinforced inside with PRF89 fabric, outside reinforced with PREF91 fabric with antifriction LFT impregnation. In some configurations, mesh, web and bougie reinforcement may be used to improve strength characteristics.

Table 3.1 will provide a list of samples of profile joints. The purpose of this test is to determine the mechanical characteristics of the profile joints according to the following parameters:

• mechanical properties (longitudinal rupture, longitudinal compression force);

• determination of the dependence of the required vertical load on the degree of their compression;

• frictional properties.

Sample X0 (profile without connection and bougie) was taken as a standard, which, due to its integrity, has the highest test rates.

3.1 Rupture testing

During testing the samples of the sealing profile on a tensile testing machine FM-250 (Figure. 3.1), the data shown in figure 3.2 were obtained, and shows the advantage of the reference sample, as well as the high characteristics of the mechanical properties of joints with JPR reinforcement pads and bougie.

The samples were alternately fixed vertically in an FM-250 machine using special equipment. The scheme is shown in Fig 3.1.

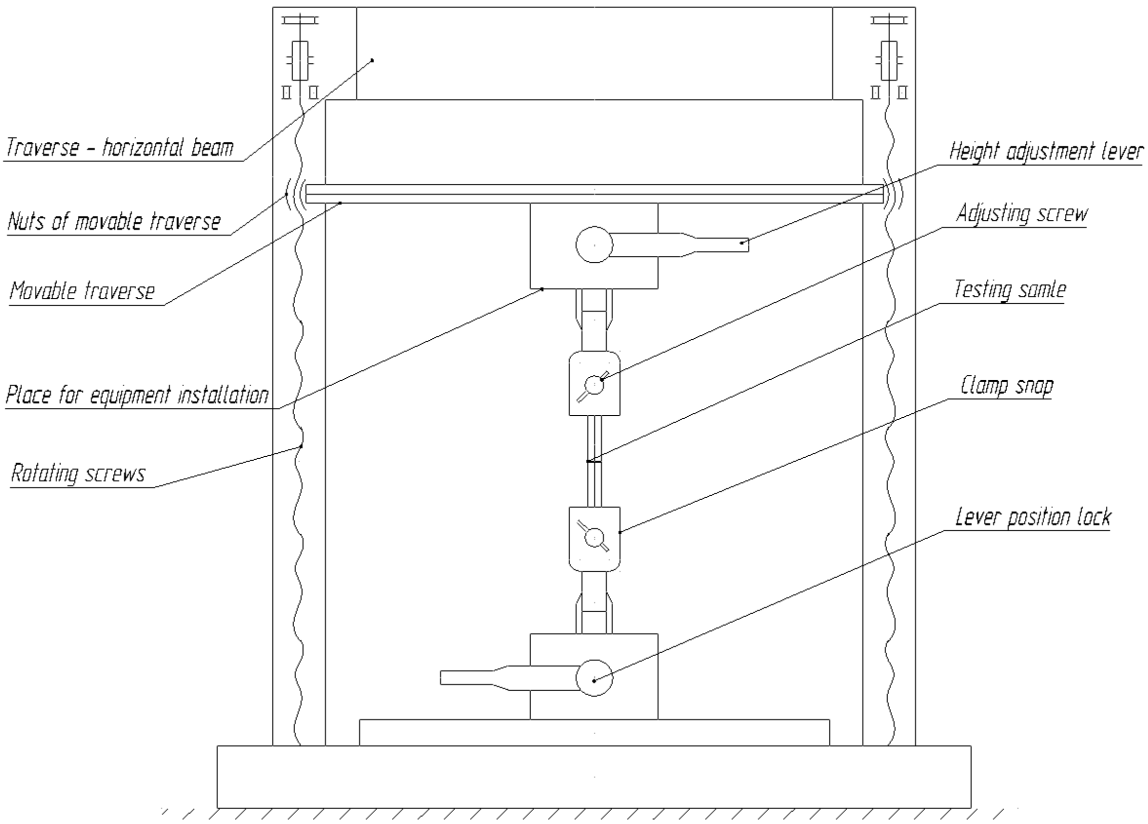

Figure 3.1 - Scheme of fixing the sample of the sealing profile during testing

Table 3.1 - List of testing sealing samples

№	Special designation	Joint type	Description	Force [kgf]
1	2	3	4	5
1	№ A1	Bougie joint Elastosil	The joint is well glued, there are no external defects.	17
2	№ A2	Bougie joint Elastosil	The joint is well glued, there are no external defects.	19
3	№ A3	Bougie joint Elastosil	The joint is well glued, there are no external defects.	15.5
4	№ B1	Bougie joint PRF	The joint is well glued, there are no external defects.	21
5	№ B2	Bougie joint PRF	The joint is well glued, there are no external defects.	25
6	№ B3	Bougie joint PRF	The joint is well glued, there are no external defects.	21
7	№ B4	Bougie joint PRF	There is a step at the junction of 0.1 - 0.2 mm.	23

Continuation of table 3.1

1	2	3	4	5
8	№ B5	Bougie joint PRF	The joint is well glued, there are no external defects.	21
9	№ C1	Reinforced joint fabric	The pad has a hairiness, there is a step in the place of contact 0.1 - 0.2 mm.	21
10	№ C2	Reinforced joint fabric	The pad has a hairiness, there is a step in the place of contact 0.1 - 0.2 mm.	19
11	№ C3	Reinforced joint fabric	The pad has a hairiness, there is a step in the place of contact 0.1 - 0.2 mm.	21
12	№ D1	Joint without reinforcement and bougie	The joint is well glued, there are no external defects.	16
13	№ D2	Joint without reinforcement and bougie	The joint is well glued, there are no external defects.	11
14	№ D3	Joint without reinforcement and bougie	The joint is well glued, there are no external defects.	15
15	№ E1	Joint reinforced mesh	There is a step at the junction of 0.1 - 0.2 mm.	24
16	№ E2	Joint reinforced mesh	There is a step at the junction of 0.1 - 0.2 mm.	16
17	№ E3	Joint reinforced mesh	There is a step at the junction of 0.1 - 0.2 mm.	20
18	№ F1	Joint with reinforcement plate T-300	There is a step at the junction of 0.1 - 0.2 mm.	16
19	№ G1	Joint with JPR reinforcement	There is a step at the junction of 0.1 - 0.2 mm.	51
20	№ G2	Joint with JPR reinforcement	There is a step at the junction of 0.1 - 0.2 mm.	56
21	№ G3	Joint with JPR reinforcement	There is a step at the junction of 0.1 - 0.2 mm.	65
22	№ G4	Joint with JPR reinforcement	There is a step at the junction of 0.1 - 0.2 mm.	75
23	№ H1	Joint with reinforcement plate (canvas)	There is a step at the junction of 0.1 - 0.2 mm.	70

End of table 3.1

1	2	3	4	5
24	№ H2	Joint with reinforcement plate (canvas)	Adhesive applied unevenly, there is a step at the junction.	59
25	№ J1	Joint without reinforcement with bougie	Adhesive applied unevenly.	17
26	№ J2	Joint without reinforcement with bougie	Adhesive applied unevenly.	12
27	№ J4	Joint without reinforcement with bougie	The joint is well glued, there are no external defects.	9
28	№ J5	Joint without reinforcement with bougie	Adhesive applied unevenly.	6
29	№ J5	Joint without reinforcement with bougie	The joint is well glued, there are no external defects.	13
30	№ J6	Joint without reinforcement with bougie	Adhesive applied unevenly.	21
31	№ X0	Sample without connection	Standard	92

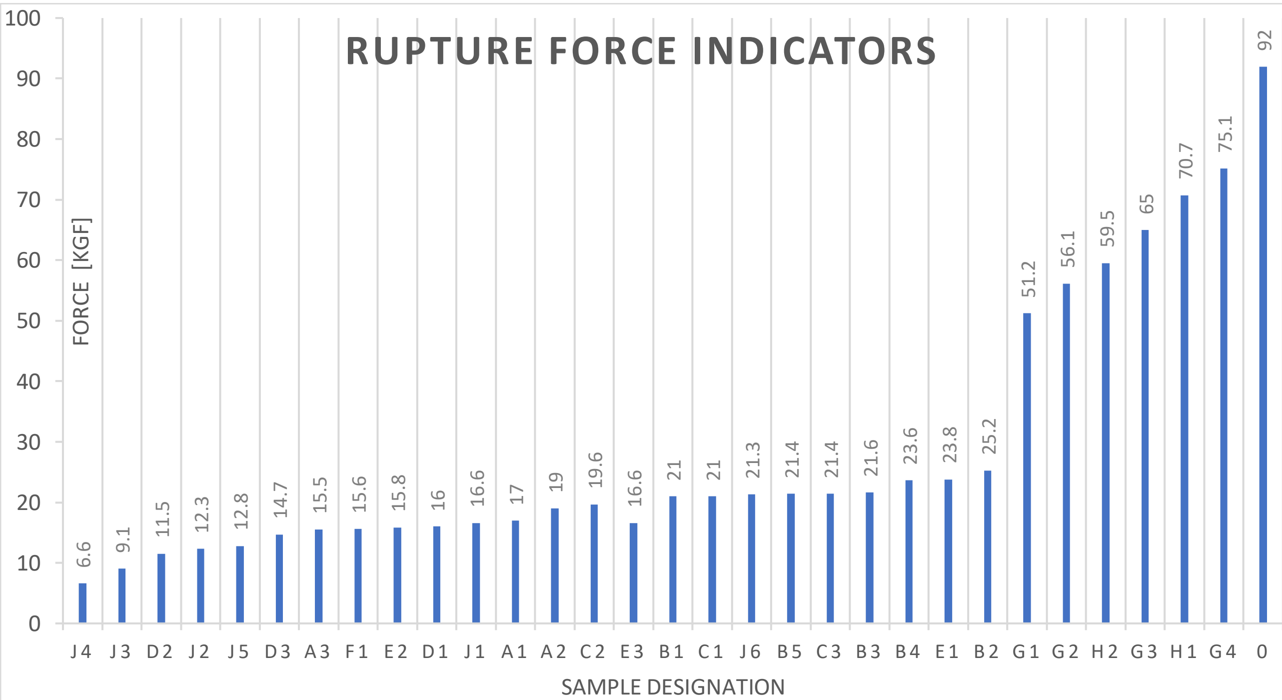

Figure 3.2 - Rupture force indicators

According to the test results, the better tensile strength was shown by sample No. G4 (profile with bougie and canvas) - 75.1 kgf (81% of the resistance of the reference sample 92 kgf).

3.2 Tests for elastic properties

The tests were carried out on a straight section and in the middle of the radius (profile deformation after 1mm). The test results are recorded in graph 1.1 in the working range of compression 1-5 mm. Figure 2 shows a diagram of specimen fixation during testing for elastic properties. The tests were carried out alternately for all samples in the range from 1 to 10 mm with a step of 1-2 mm.

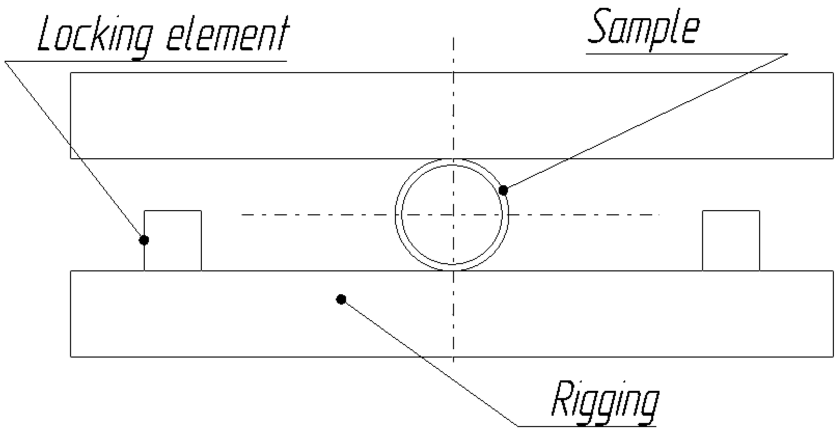

Figure 3.3 - Typical cross-section of a test section

Table 3.2 shows the elastic properties of the profiles:

Table 3.2 - Elastic properties

№	Elastic properties of profile joints				
	1 mm	2 mm	3 mm	4 mm	5 mm
1	2	3	4	5	6
A1	1	2,1	4,8	10,1	17,6
A2	2	3	5,7	11	17,4
A3	1,7	2,6	5,6	10,6	16
B1	2,8	4	7,7	15,6	25
B2	2,7	3,9	7,2	15,6	23
B3	1,4	2,6	5	8,8	12,6
B4	2	3,4	6,7	12	17,2
B5	1,8	2,8	5,2	9,6	15
C1	1,8	2,2	4	7,8	11,6

End of table 3.2

1	2	3	4	5	6
C2	1,6	2,6	3,6	7	10,2
C3	1,2	1,8	3,2	6,2	8,8
D1	1	1,6	3,2	5,8	7,6
D2	0,4	0,6	1,8	3,6	5,2
D3	0,4	0,8	1,8	3,6	5,2
E1	1	1,8	3,8	7,2	8
E2	0,6	1,2	3	6	8
E3	0,8	1,4	3,2	4,5	8,8
F1	0,8	1,4	2,6	5,6	8,4
G1	0,6	1,2	2,6	5,6	8,2
G2	0,6	1,4	2,6	4,6	6,4
G3	1	1,6	3,2	6,2	9,1
G4	3,4	4,8	8,2	16,6	27,2
X0	0,3	0,5	0,9	1,7	2,4
H1	0,5	0,8	1,4	2,7	3,7
H2	0,4	0,7	1,3	2,4	3
J2	0,4	0,7	1,2	2,2	5,6
J3	0,3	0,6	0,8	1,4	2
J4	0,3	0,4	0,8	1,6	2,4
J5	0,3	0,5	1	2	3
J6	0,3	0,5	1	1,8	2,6
J1	0,4	0,8	1,6	2,6	3,4

Results of experiment about elastic properties of mechanization profiles are represented in Figure 3.4.

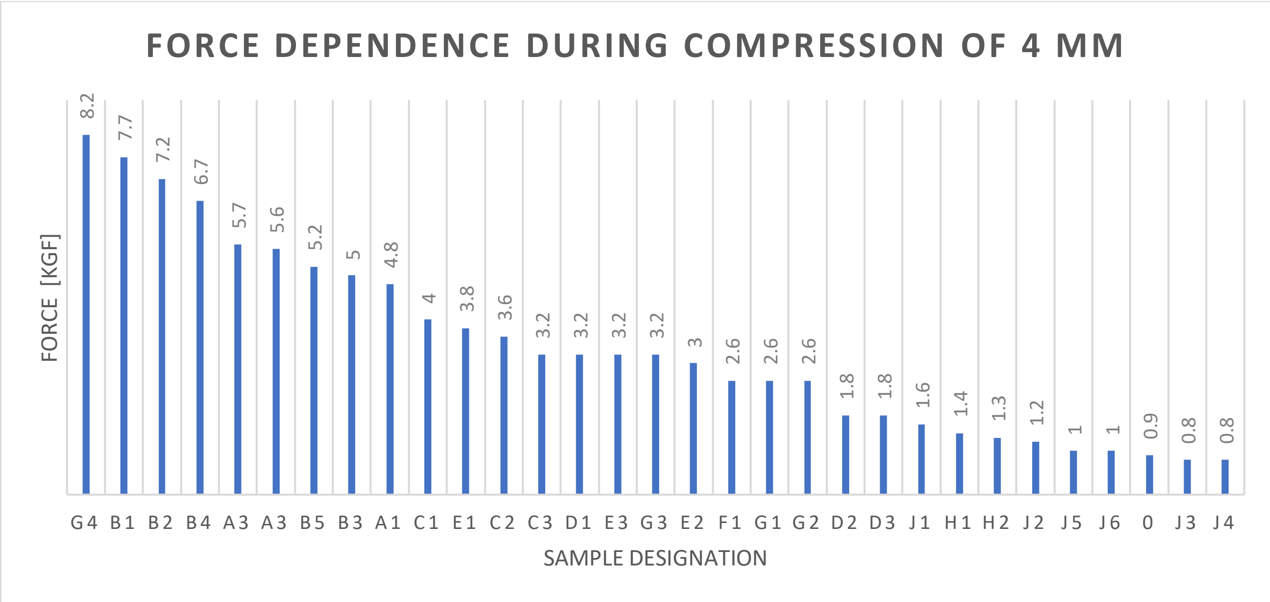

Figure 3.4 - Force dependence during compression of 4 mm

3.3 Tests for frictional properties

Tests for frictional properties were carried out at a compression of 4 mm using specially designed equipment and a dynamometer measuring tool. The results of testing the frictional properties of sealing are shown in figure 3.6

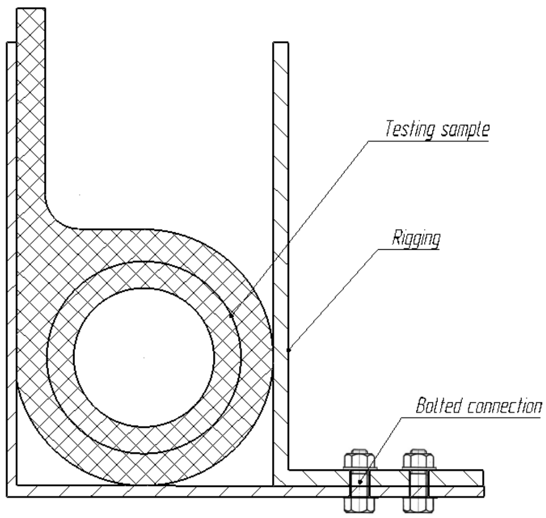

Figure 3.5 - Typical cross-section of a test section

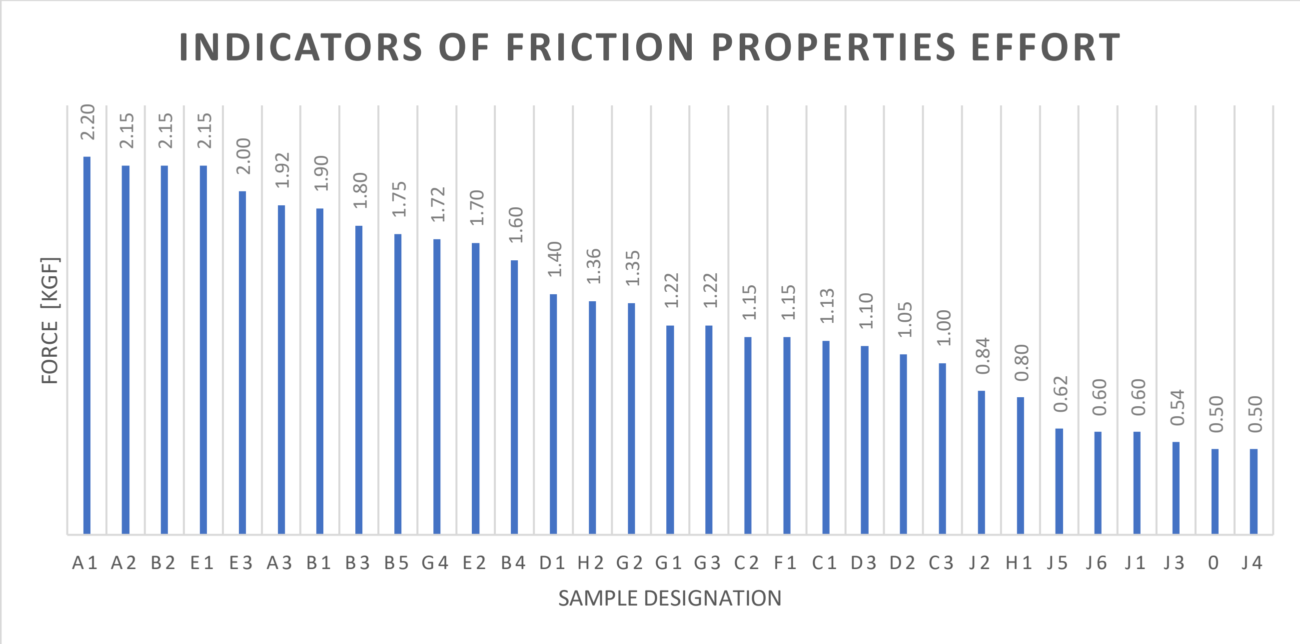

Figure 3.6 - Indicators of friction properties effort

3.4 Determination of the removal force of profiles fixed with sealants.

In connection with the need to fix the sealing profiles on the surface of the fuselage mechanization, it is necessary to determine the vertical force that causes the profiles to separate from the plate. Profiles fixed with sealants:

1. Dowsil-732
2. Vixint-18
3. VGO-1
4. VITEF

The object of laboratory testing is 4 samples of a profile with an inner diameter of 15 mm and an outer diameter of 18 mm. They have a flat base measuring 2x5 cm, reinforced with polyester fabric. The samples are four 50mm long profile sections. Profiles glued to a flat stainless-steel plate without chemical passivation.

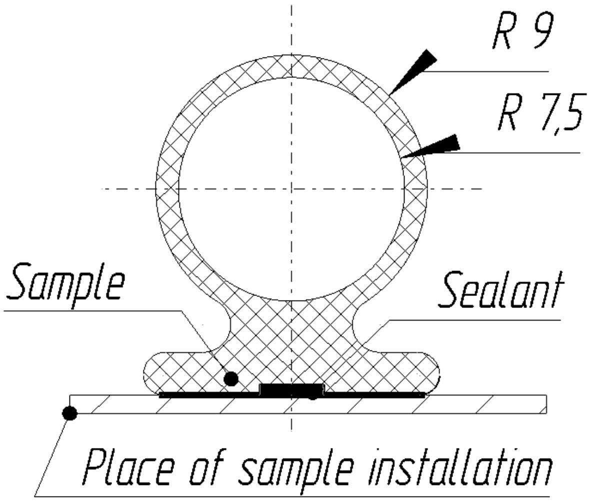

Figure 3.7 - Typical cross-section of a sample

To carry out the test, insert the rod into the eyelet of profile figure. 3.8 and fix it from both ends to the dynamometer with the help of the cable, the plate must first be rigidly fixed with the fixing eluent. The alternate position of the elements relative to the plate is shown in figure 3.8 the indentation of the fixing element the plates from the profile should not exceed 10 mm.

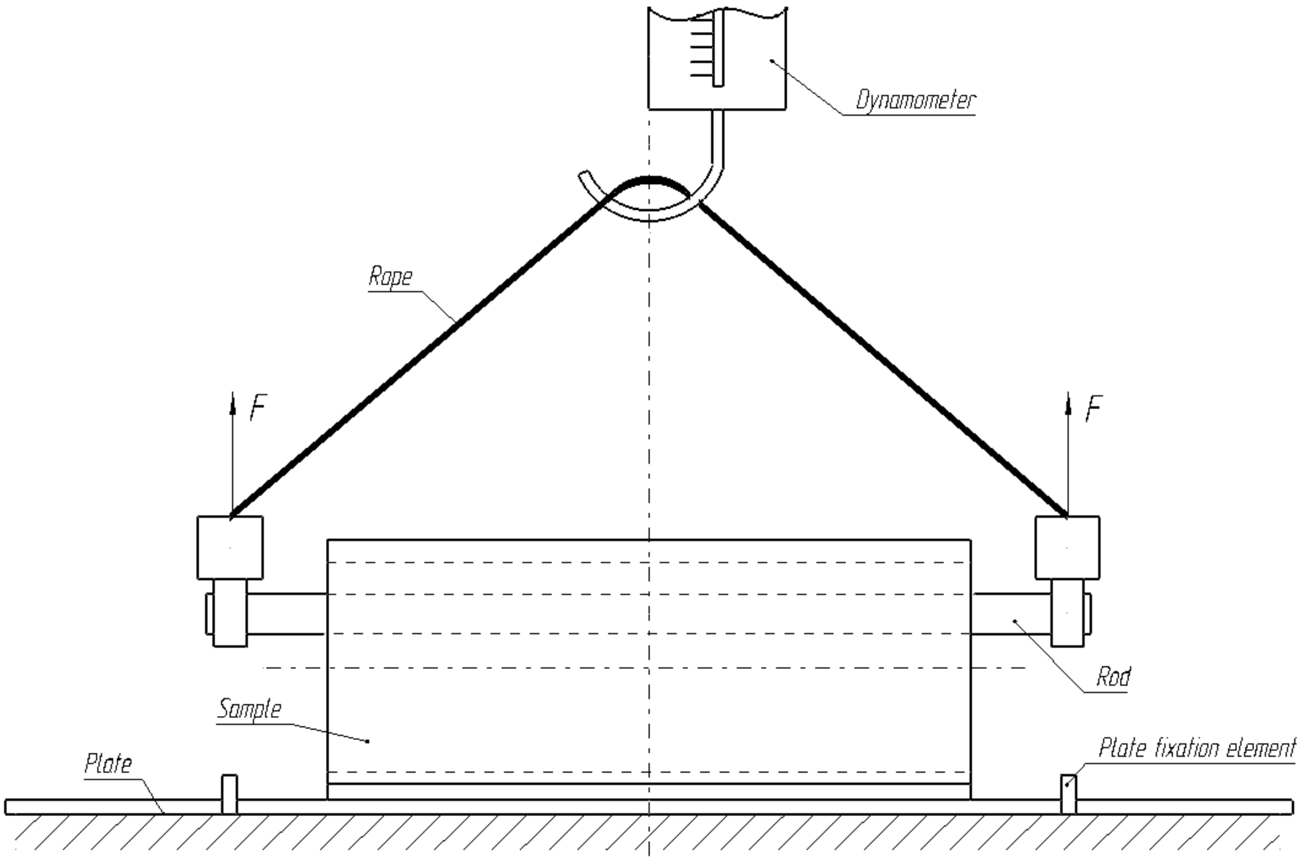

Figure 3.8 - Profile installation scheme during testing

During test, an assessment of the manufacturability and mechanical properties of the Dowsil-732 adhesive sealant in the construction of the installation of the door and hatch sealing profile was obtained, and the determination of the possibilities of its further use in the design of AN products. So, we need provide:

1) determination of the force of separation of samples of sealing profiles;

2) determination of the contact area of sealants;

3) calculation of the specific pull-off force kgf / cm for these samples depending on the sealant used.

For testing, inside the profile with a base area of 10 cm (see Fig. 3.8), a rod with a diameter of 12 mm is inserted, connected by both ends to dynamometer using a cable. Plate is preliminarily rigidly fixed by a fixing element to the working table at a distance from profile ends about 10 mm.

When testing samples of the sealing profile to determine the force of their separation from the plate on a tensile testing machine FM-250, the data given in Table 1 were obtained. There are no external defects during the gluing of the samples.

Table 3.3 – List of testing samples

№	Sample fixing method	Contact area [cm^2]	Breakout force [kgf]
1	Dowsil-732	Profile glued by area 7.425	23.6
2	Vixint-18	Profile glued by area 9.152	16.1
3	VGO-1	Profile glued by area 7.002	15.9
4	VITEF	Profile glued by area 7.626	24.5

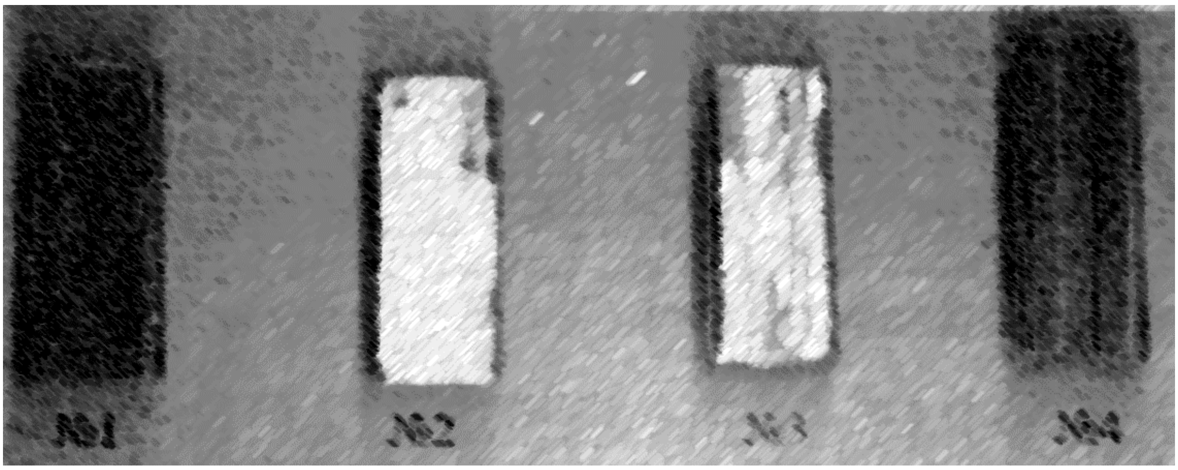

Figure 3.9 - The distribution of sealants on the seal samples

Adhesion of the contact of the tab of the sealing profile sample with the sealant. Table 2 shows the calculation of the specific breakout force per 1 kgf / cm^2.

Table 3.4 – Results of experiment

№	Sample fixing method	Breakout effort [kgf]	Square gluing [cm^2]	Square gluing [%]	Specific breakout force [kgf/cm^2]
1	Dowsil-732	23.6	7.425	74	3,178
2	Vixint-18	16.1	9.152	91	1,759
3	VGO-1	15.9	7.002	70	2,270
4	VITEF	24.5	9.626	96	2,545

Below on figure 3.10, the magnitude of the specific force of separation from the plate of each sample of the sealing profile is shown in detail.

The data on the gluing area of the profiles were entered in table 3.3 in the description section. The data presented was obtained by measuring the area of a polyhedral surface highlighted in Figure 3.10.

The calculation of the specific breakout force kgf/cm for different types of sealants is carried out by dividing the breakout force kgf by the contact area cm according to table 3.4:

1) $23{,}6\ kgf/7{,}425\ cm^2 = 3{,}178\ \frac{kgf}{cm^2}$

2) $16{,}1\ kgf/\ 9{,}152 cm^2 = 1{,}759 \frac{kgf}{cm^2}$

3) $15{,}9\ kgf\ /7{,}002\ cm^2 = 2{,}270\ \frac{kgf}{cm^2}$

4) $24{,}5\ kgf\ /9{,}626\ cm^2 = 2{,}545\ \frac{kgf}{cm^2}$

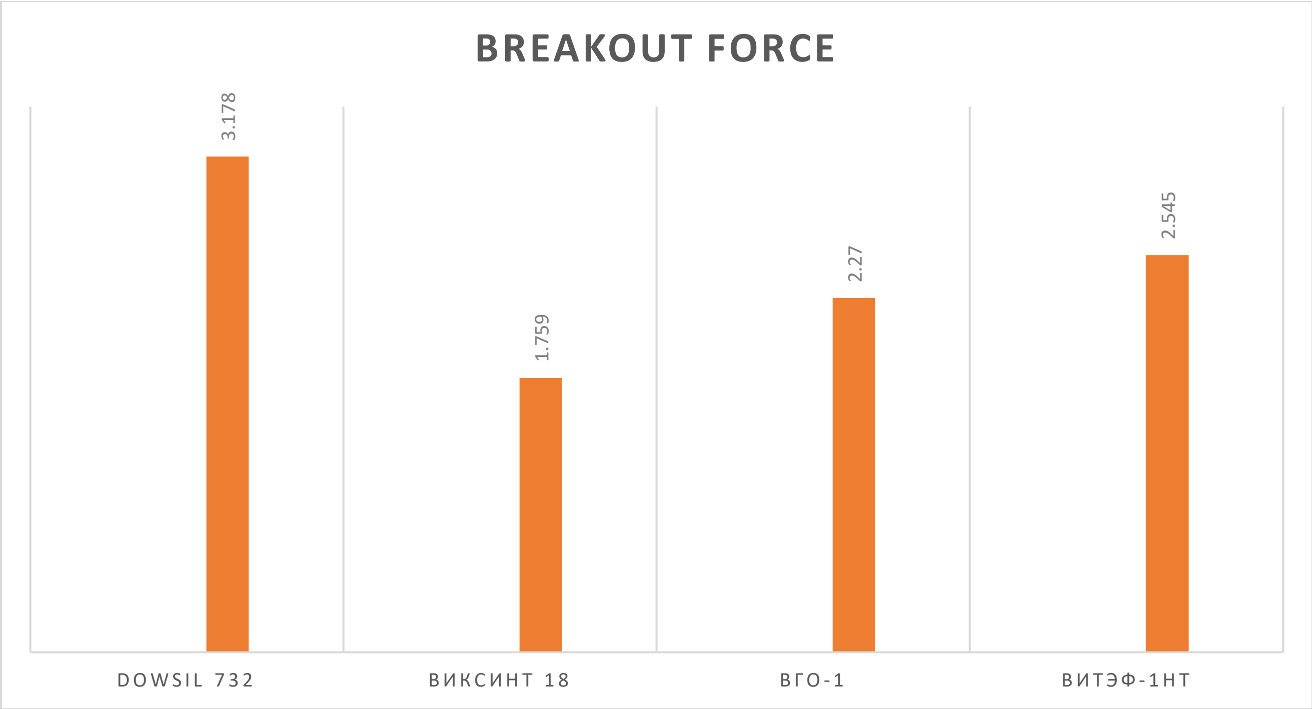

Figure 3.10 - Breakout force

The test established:

- on samples № 1 and № 2, the sealant almost completely remains on the sealing profile;
- sample №1 has the highest breakout force from the plate, having the best adhesion when fixed with Dowsil-732 sealant;
- samples № 3 and №4 have increased adhesion to the plate, because most of the sealant remains on it;
- sample №4, glued with VITEF-1 sealant, has a high adhesion to the plate relative to other sealants (when torn off, the sealant remains completely on the plate).

According to histogram 3.4, samples with a joint with a JPR reinforcement plate and the presence of a bougie have indicators of mechanical properties (longitudinal rupture tests) 50% higher than those without corresponding reinforcement. The lowest rates are demonstrated by the samples having the web as reinforcement.

According to the test results, the best elastic properties are shown by the joints of profiles without reinforcement and bougie J3, J4, and profiles with bougie have low elastic properties (0.84 - 0.5 kgf).

When tested for frictional properties, profiles with a bougie A1, A2, B2 and profiles with reinforcement E1, E2 showed the highest friction force.

CONCLUSION TO PART 3

1. Tests of mechanical properties for tensile strength showed that the highest resistance was demonstrated by sample No. G4 (profile with bougie and web) with a force equal to 75.1 kgf.

2. Tests for elastic properties show the best performance for the joints of profiles with a bougie (elastosil) G4, B1, and profiles without reinforcement and bougie have low elastic properties equal to 0.84-0.5 kgf.

3. Tests for frictional properties have shown that profiles with bougies (A series) and reinforcement pads (E series) have the highest friction values equal to 2.1-2.2 kgf.

This analysis establishes that the JPR sealing profile has successfully passed the test of the profile joint samples for mechanical properties such as longitudinal rupture, longitudinal compression force and friction properties. It was determined that the best mechanical properties were in the samples with bougie and reinforcement sheet A1, A2, G4. When determining elastic properties, specimens with a bougie and a reinforcement sheet G4, B1, B2 have pronounced advantages. Friction tests showed similar results. According to these tests, it was found that the most reliable joints of sealing profiles are joints with bougie and reinforcement sheet.

4 LABOR PROTECTION

4.1 Analysis of harmful and dangerous production factors

In the production of sealing profiles, the technology of rubber, silicone or mixed joints extrusion is used. This technology is provided with the help of equipment located in the workshop, such as:

- a container for storing raw materials,
- an extruder device,
- a cooling bath,
- a device for stitching with reinforced thread,
- a device for cutting,
- a container for collecting finished products.

This production line is installed in the workshop of production and is aimed to ensure the manufacturability of production. Such equipment is installed at special enterprises for the manufacture of rubber technical products, respectively, all labor protection standards must be thought out and observed at the stage of planning and construction of the enterprise.

On this line there should be workers who control and direct the process of extrusion of rubber technical products. This is the operator of the extruder who delivers raw materials to the device, and then guides the first guided end of the product along the line to pass through the cooling bath, and then to the piercing [3]. As well as additional operators whose tasks include control and selection of operating modes for individual elements on the production line. As a result, up to 5 workers can be on one line.

To ensure working conditions in such a production, artificial sources of light, climate control, air conditioning and air removal must be available. All listed devices are electrical and operate from a common power supply.

According to this technological process for the production of rubber technical products, several harmful factors can be distinguished according to GOST 12.0.003-74. First of all, the operator is dealing with a movable product that must be guided manually to ensure the implementation of the process, therefore the first paragraph of section 1.1.1. Physical hazards and harmful production factors fall under this type of operation “moving machines and mechanisms; moving parts of production equipment; moving products, blanks, materials; collapsing structures; collapsing rocks;”. According to the concept of occupational health, the following recommendations should be highlighted, which can ensure that there is no negative impact on the health and functional state of the employee, the process of feeding the workpiece should be carried out in accordance with safety measures, as well as in the presence of all the necessary protective kit provided for by safety measures.

The next point that workers encounter when working on this line is the increased or decreased air humidity, which occurs due to the fact that during the cooling process of the rubber of a technical product in an open bath, constant evaporation of moisture occurs, which leads to a significant increase in air humidity. To prevent this impact, it is necessary to use modern air conditioning systems and climate control in production.

And so according to paragraph 1.1.4.2. “Neuropsychic overload” in the form of monotony of work manifests itself during the work process. In view of the fact that the control of a product implies concentration and attentiveness on one object in a limited environment.

Thus, this production is characterized by three harmful production factors, such as:

- moving machines and mechanisms; moving parts of production equipment; moving products, blanks, materials; collapsing structures; collapsing rocks;
- increased or decreased air humidity;
- monotony of work.

Among these three presented factors, high humidity should be highlighted, since it is the most harmful factor to ensure the leveling of which it is necessary to install air conditioning systems and air ducts to remove and circulate air in the room.

4.2 Measures to reduce the impact of harmful and dangerous production factors

The calculation of the ventilation system begins with determining the air capacity (air exchange), measured in cubic meters per hour. For calculations, we need a plan of the facility, and the area of all rooms. The calculation is usually carried out in accordance with “СНиП” 41-01-2003 and “МГСН” 3.01.01.

After calculating the air exchange for people, we need to calculate the air exchange rate (this parameter shows how many times a complete air change occurs in the room during one hour). To prevent the air from stagnating in the room, at least one air exchange must be provided.

Thus, in order to determine the required air flow rate, we need to calculate two values of air exchange by the number of people and by frequency, and then select the larger of these two values.

Calculation of air exchange by the number of people:

$$L = N \times L_{normal} = 15 \times 60 = 900\ [kg/m^2] \quad (1)$$

where L is the required capacity of the supply ventilation, m^3 / h; N is the number of people; L_{norm} is the rate of air consumption per person: at rest (sleep) - 30 m^3 / h; typical value (according to СНиП) - 60 m^3 / h;

Calculation of air exchange rate:

$$L = n \times S \times H = 3 \times 600 \times 3 = 5400\ [kg/m^2] \quad (2)$$

where L is the required capacity of the supply ventilation, m^3 / h; n - standardized rate of air exchange: for residential premises - from 1 to 2, for offices - from 2 to 3; S is the area of the room, m^2; H - room height, m;

So, we choose the air exchange rate quality amount.

After determining the ventilation capacity, you can proceed to the design of the air distribution network, which consists of air ducts. To calculate the dimensions (cross-sectional area) of air ducts, we need to know the volume of air passing through the air duct per unit of time, as well as the maximum allowable air speed in the duct. The calculation of the air distribution network begins with drawing up a diagram of the air ducts.

In practice, for industrial premises, the air velocity in the duct is 5-6 m / s, since at higher air velocities the noise from its movement in the ducts and distributors may become too noticeable.

So, the estimated cross-sectional area of the duct is determined by the formula:

$$Sc = L \times \frac{2.778}{V} = 5400 \times \frac{2.778}{4} = 3750\ [cm^2] \quad (3)$$

where S_c is calculated cross-sectional area of the air duct, cm^2; L - air flow through the duct, m^3 / h; V is the air velocity in the duct, m / s; 2.778 is a coefficient for reconciling different dimensions (hours and seconds, meters and centimeters).

Thus, in order to ensure the necessary parameters of air circulation in this room, it is necessary to use three air ducts with a total cross-sectional area of 1250 mm^2 of each, and we choose the dimensions of a rectangular ducts 250 × 500 mm or a diameter of a round ducts Ø 400 mm. Which at an air speed of 6 m/s provide $2700 \times 3 = 8100\, m^3 / h$ of air flow, that is satisfied necessary conditions.

4.3 Occupational safety instruction

4.3.1 General labor protection requirements

1. Individuals who are at least 18 years old and have appropriate professional training are allowed to work independently on the extruder in the production of polyethylene film.
2. Passed in the prescribed manner medical examination, introductory briefing and primary instruction at the workplace on labor protection, training in safe methods and techniques of work.
3. Passed an internship and knowledge test on labor protection issues in the scope of qualification requirements (hereinafter referred to as an employee).
4. The employee is obliged to comply with the requirements of the internal labor regulations, comply with the requirements of labor protection and personal hygiene.
5. Perform only the work that is entrusted to him, the safe ways of doing which he knows.
6. Know the technological process of extrusion of materials, know the device and the principle of operation of the equipment, the power supply diagram of the unit, the rules for adjusting the mechanisms to the given parameters, know the requirements for the quality of the products.
7. Use and correctly apply personal protective equipment (PPE)

The employee is provided with PPE in accordance with established standards

Cotton suit (cotton robe)	12 h
Headdress	12 h
Leather boots	12 h
Knitted gloves	Up to wear

An employee, if necessary, can be issued free of charge for protection:

• eyes from exposure to dust, solid particles, laser beams - goggles or face shields;

• hearing organs from exposure to noise - anti-noise earmuffs or earbuds;

• respiratory organs from exposure to dust, smoke, vapors and gases - respirators.

8. Observe the technology of production of work, apply methods that ensure labor safety.

9. Comply with fire safety requirements, know the warning signals in case of fire, the procedure for action in case of fire, the location of the primary fire extinguishing means and be able to use them.

10. Inform your immediate supervisor about any situation that threatens the life and health of people, about every accident, noticed malfunctions of devices or equipment, tools, about the deterioration of your health, incl. on the manifestation of signs of an acute illness.

11. To undergo, in the manner prescribed by law, medical examination, training, internship, briefing and testing of knowledge on labor protection and fire safety.

12. An employee is prohibited from being in a state of alcoholic intoxication or in a state caused by the use of narcotic drugs, psychotropic or toxic substances, drinking alcoholic beverages, using narcotic drugs, psychotropic or toxic substances at the workplace or during working hours, smoking in unidentified places, performing work without the use of relying PPE.

13. In the process of work, the employee may be affected by the following harmful and hazardous production factors:

• moving machines and mechanisms, moving parts of production equipment;

• increased voltage value in the electrical circuit;

• increased or decreased air temperature of the working area;

• insufficient illumination of the working area;

• sharp edges, burrs and roughness on the surface of raw materials, tools, equipment;

• increased dust and gas content of the air in the working area;

• increased levels of noise and vibration;

• chemical substances.

14. An employee who fails to comply with labor protection requirements is held liable in the manner prescribed by the legislation of the Ukraine.

4.3.2 Labor protection requirements before starting work

15. Check the serviceability of the equipment, in case of any malfunctions, take measures to eliminate them.

16. Before starting work, the employee is obliged to check the serviceability of the PPE necessary to perform the work. Put on clean overalls, fasten all the buttons, put on special shoes. Remove hair under the headdress.
17. Check the presence and strength of the fastening of the guards, cleanliness and order at the workplace.
18. Inspect the condition of the extruder electrical equipment and the reliability of the grounding device. If any faults are found, contact the electrical personnel for their elimination.
19.Check the serviceability of the air supply system.
20. Check the integrity and reliability of the film cutting unit. The protective cover must be intact and easy to close.
21. Check the serviceability of the working tool and devices.
22. Check if the local exhaust and general supply and exhaust ventilation systems are on.
23. Check and adjust the lighting of the workplace.
24. Make sure that there are no unauthorized persons near the workplace.
25. The employee is obliged to immediately inform the work supervisor about all the shortcomings and malfunctions found at the workplace and not to start work until the malfunctions are eliminated.

4.4.3. Requirements for labor protection during the performance of work

26. When performing work, the employee is obliged to monitor the operating mode of the equipment (temperature, pressure), the tension of the drive belts, the operation of automation and interlocking devices, timely lubricate the bearings, and clean the magnetic protection.
27. Monitor the condition of instrumentation (pressure gauges) installed in the pneumatic line of the compressors.
28. Raise and lower the covers only using the raise and lower buttons, do not keep your fingers in the open area of the covers.
29. It is forbidden to spill water and oils in the area of the extruder.
30. Change the filter with a special tool - a puller.
31. It is necessary to clean the extruder head from the substandard film with a brass knife.

32. Do not put hands on the cutting unit when threading the film through the shafts of the cutting unit.
33. It is forbidden to touch the extruder head with your hands when loading the film onto the rolls in the cooling bath, the working rolls when filling the film, as well as during operation.
34. Eliminate damage and repair the equipment only when the voltage is completely removed from the equipment.
35. An employee is prohibited from:
• push the mixture by hand into the receiving funnel of the extruder;
• start the extruder with the screwed part clogged with the product;
• clean the hole of the outlet sleeve when the extruder is running;
• to disassemble the screw part at temperatures above 90 ° C without heat-resistant gloves.
36. During the dismantling of the outlet bowl, it is forbidden for the operator to stand in front of the screw part. It should be borne in mind that under the pressure of the mixture being processed, the outlet bowl can be thrown forward, and the hot mixture can get into the eyes and face. Dismantling should be carried out after the screw part has cooled down to a temperature of no more than 40 ° C.
37. Extruders should be equipped with local ventilation devices to remove dust and gaseous products from the work area.
38. The extruder heads must have reliable thermal insulation of the outer surfaces.
39. Places of possible release of molten material should be equipped with protective screens.
40. When extruders are released from hot polymeric materials (in case of an accident, rejects, stopping machines), the material should be discharged into specially designed mobile containers with lids and taken out of the workshop to a specially established place.
41. The loading of polymeric materials into the bunkers of the extruders should be carried out by mechanical devices.
42. Drive shafts, gearboxes, couplings that drive the sluice gates must be securely guarded.
43. Testing the rotation of the impeller of the airlock should be done by hand by the end of the shaft; rotation of the impeller by the blades is prohibited.

44. If a foreign object enters the gate valve or is blocked by a product, the removal of a foreign object or the elimination of the blockage should be carried out after disconnecting the electric motor from the electrical network and completely stopping the rotation of the impeller.
45. The augers should be enclosed in sturdy boxes with removable covers. The covers must be closed. Protective grilles must be installed under removable covers. Opened hatches not only contribute to dusting the workshop, but also create the danger of accidental hand or foot falling into the working area of the auger, which can cause injury.
46. In the event of a blockage of the auger or a foreign object getting into it, the removal of the object or the elimination of the blockage can only be done when the machine is completely stopped.
4.4.4 Labor protection requirements at the end of work
47. At the end of the work, you must turn off the equipment used.
48. Make cleaning of the workplace.
49. Take off PPE, place them in storage.
50. Follow the rules of personal hygiene.
51. Inform the supervisor of work on all faults noticed during work and on its completion.
4.4.5. Labor protection requirements in emergency situations
52. In the event of an emergency, turn off the equipment in use immediately.
53. Stop all work not related to the elimination of the accident, take measures to provide first (pre-medical) aid to victims, take measures to prevent the development of an emergency situation and the impact of traumatic factors on other persons, ensure the withdrawal of people from the danger zone if there is a danger to them health and life.
54. Report the incident to the work supervisor.
55. Work can be resumed only after elimination of the causes that led to the emergency.
56. In the event of a fire, call the emergency department by phone 101, inform the supervisor of the incident, take measures to extinguish the fire with the available fire extinguishing means. The use of water and foam fire extinguishers to extinguish live electrical equipment is not allowed. For these purposes, carbon dioxide and powder fire extinguishers are used.

57. In case of an accident at work, it is necessary to take measures to prevent exposure of the victim to traumatic factors, to provide the victim with first (pre-medical) aid.
58. Call medical workers to the scene of the accident or deliver the victim to the health care organization, report the incident to the work manager.
59. Ensure the safety of the situation at the scene of the incident before the start of the investigation, if there is no threat to the life and health of others, otherwise - to fix the situation by drawing up a diagram, protocol, photographing or by another method.
60.In all cases of injury or sudden illness, it is necessary to call medical workers to the scene of the accident by phone 103, if it is impossible - to take the victim to the nearest health organization.

5 ENVIRONMENTAL PROTECTION

5.1 Acoustic pollution of the atmosphere

Aviation noise is the most important factor in the negative attitude of the population to aviation in the territories adjacent to the airport. It affects a relatively large number of people living in the surrounding area, as well as airport employees and passengers. Aviation noise has a negative impact on people's health (most often it is hearing loss, stress, problems related to concentration) [4].

Noise can adversely affect a person. If the noise level is high and the effect is prolonged, it may cause hearing loss. A worker who stands day after day at a rattling machine, or a musician who plays in an orchestra, may experience permanent hearing loss if they are exposed to heavy noise for a number of years. Deafness has long been considered an occupational disease of printers and textile workers. Even if the noise is short-lived, such as the sound of a jackhammer, it can still cause hearing problems. However, it is not necessary to be exposed to harmful effects every day.

Noise is perceived by most people as something annoying and disturbing, causing psychological and emotional stress that is difficult to measure. Noise can cause General irritability, interfere with normal sleep, and affect the efficiency of work and speech communication. Unexpected noise, such as the passage of a supersonic plane through the sound barrier, or noise whose source cannot be immediately identified, is particularly annoying. Perhaps, in this case, the natural instinct of self-preservation manifests itself.

Long-term exposure to noise causes chronic fatigue, headaches, and discomfort in many people, even if the noise level is lower than the one that actually causes pain. Doctors try to determine how the body reacts to noise by recording blood pressure, voluntary and involuntary musculature, changes in the nature of breathing, blood circulation, digestive juices, and other characteristics that indicate increased tension in the body. The human response to noise is diverse and complex, and little is known about the long-term effects of psychological stress associated with it.

There are many socio-economic consequences of acoustic pollution. Sound insulation systems increase the cost of buildings. The price of housing in areas with high noise levels is falling. In many places, there are sharp conflicts with residents due to the construction or expansion of airports-significant sources of noise.

ICAO's policy on aviation noise includes the development of measures to mitigate acoustic pollution: the introduction of noise reduction technologies, ground planning (for example, bans on night flights), stricter noise standards for the existing fleet of aircraft, and the development of standards for new aircraft models. At one time, due to the introduction of strict standards for aviation noise, Russia lost the ability to operate domestic aircraft for international flights, which caused a huge blow to the domestic aircraft industry. Currently, fundamentally new aircraft designs and engine concepts are being developed, and manufacturers strive to ensure that their products meet the highest requirements of environmental standards. Standards and recommended practices for aviation noise are set out in the first volume of Annex 16. Here formulated permissible noise levels and methods of measurement for any different categories (i.e. year of release, number of engines and their type, maximum certified take-off mass of the sun). For the development of noise reduction technologies, a group of independent experts created by CAEP has formulated medium-term (until 2020) and long-term (until 2030) technological goals. They represent standards that will be mandatory for four categories of aircraft in 2030. The goals are shown as noise reduction values relative to the limit parameters of the nominal and maximum take-off weight. The noise level is measured in units of EPN dB-the effectively perceived noise level in decibels. Given that in 2014 these levels, depending on the type of aircraft, were 89 10 106 EHRN dB, it becomes clear how radically ICAO is going to deal with acoustic pollution of the atmosphere.

Efficient jet engines have been developed for more than 50 years, but they are still the most voracious of all. Even the most modern passenger aircraft of the new generation Boeing 737 or Airbus A321, equipped with fuel-efficient engines and winglets that reduce fuel consumption, consume about 3,000 liters per hour of flight (or 3-3. 5 liters per kilometer of flight). During a single flight, the aircraft consumes aviation fuel in a volume comparable to the amount of gasoline that is burned by one car per year.

Tens of thousands of flights a day around the world have a significant impact on the environment, as each litre of aviation fuel burned produces more than 2.5 kg of $CO2$. Even at this scale, the figure looks scary, but let's calculate how much CO2 emissions a plane will produce in one flight over a distance of 1000 km. The figure of 9 tons of emissions is probably shocking to many.

Today, civil aviation is responsible for 3% of the world's greenhouse gas emissions. This in itself is a lot, but due to the fact that the upper atmosphere is polluted, the effect of such pollution is even stronger. Aircraft flying short distances at low altitudes have less of an effect on the greenhouse effect, but in absolute numbers they produce the most pollution. Frequent take-offs and landings, when the engines are running at full power, worsen the statistics on pollution. And now some real examples of how much planes pollute the environment:

The SAS flight from Helsinki to London, operated by Avro RJ85 (a small four-engine jet with a maximum capacity of 112 passengers), flies 1,850 km and burns about 7,000 liters of aviation fuel. The amount of carbon dioxide emissions is 17.5 tons.

The S7 flight from Moscow to Saint Petersburg, operated by an Airbus A320 (a twin-engine airliner with a maximum capacity of 164 passengers), flies 750 km and burns about 2,700 liters of aviation fuel. The amount of carbon dioxide emissions is about 7 tons. 7 tons of emissions from one aircraft per flight. Imagine the scale of pollution only on this popular route, the frequency of flights on which can reach two or three flights per hour.

The amount of pollution from civil aviation aircraft around the world cannot be accurately calculated, but the scale of the disaster is not difficult to imagine. In addition, aircraft in flight emit substances harmful to the atmosphere such as nitrogen oxides and ozone, as well as create Cirrus clouds formed from contrails. All this also negatively affects the global climate. The easiest way to protect workers from the painful effects of noise is to use earplug and special headphones. This method is used, for example, by airport employees. Another method is to use sound-absorbing or isolating materials in rooms where there are strong sources of noise.

There are other ways to deal with noise that target its source. Such solutions involve changing the design of engines to make them quieter, installing silencers on motors and mechanical devices, changing the design of tire treads, installing shock-absorbing bands on the metal wheels of railway cars and metro cars.

5.2 Aircraft engine emissions

The main part of aviation fuel is not burned in the surface layer near airports, and in the higher layers of the atmosphere. Experts believe that annually increasing emissions of carbon dioxide, water and methane from commercial aircraft engines change the chemical and radiation balance of the atmosphere, which, along with the emission of soot sulfate aerosols, can affect the climate. Components such as carbon dioxide and nitrogen oxides are particularly important. Nitrogen oxides take part in the chemistry of ozone (its increase can lead to heating of the upper troposphere) and an increase in the amount of hydroxyl radicals (OH), the main atmospheric oxidizer. An increase in IT leads to a reduction in the lifetime of methane CH4, which can result in cooling, and in parallel – on a scale of decades-a reduction in tropospheric ozone. Sulfur oxides and soot lead to the formation of aerosols.

Aerosols and their precursors (soot and sulfates) increase cloud cover in the form of linear contrails (condensation trails) and Cirrus clouds. Depending on the state of the surrounding atmosphere these traces may sometimes exist several times minutes, and sometimes hours, spreading out in width for several kilometers and resembling Cirrus or high-beam clouds. A very significant impact on the radiation balance is expected as a result of emissions of soot particles from solid-state products of incomplete fuel combustion, which play the role of condensation nuclei. In the upper troposphere, soot aerosols have a size of 0.1 - 0.5 microns and consist of agglomerates of primary particles with a diameter of 20 40 40 nm. Their average concentration varies from 0.004 to 0.5 cm-3. Previously, when assessing the climate consequences of soot aerosol emissions, the main attention was paid to changes in the atmospheric composition caused by heterogeneous chemical reactions on the surface of soot particles [5].

However, no noticeable effect of these particles on the gas composition of the atmosphere has yet been detected. Currently, it is believed that the influence of soot particle emissions on climate is mainly due to the formation of long-lived condensation traces (direct effect) and the initiation of Cirrus cloud formation (secondary effect). The radiation effect of such clouds is extremely difficult to assess – even the sign of this influence is not determined with certainty. Model estimates of the global effect of aviation soot on the radiation balance (the effect of large-Scale Cirrus clouds, in which soot particles played the role of condensation nuclei), performed using chemical transport models under various assumptions and parameterization, found differences from -110 to +260 mW / m2.

Indeed, the lack of detailed descriptions of processes in models and the completeness of observational data limits confidence in the quantitative assessment of the contribution of radiation forcing. According to calculations, the total radiation forcing due to aviation emissions (excluding induced Cirrus clouds) in 2005 was ~55 mW/m2, including Cirrus clouds ~78 mW/m2. Simplified prognostic estimates of climate radiation forcing under the influence of aviation, the figures given in the same paper show that by 2050 these figures will increase by about 3 times.

Particular attention among the products of aviation fuel combustion is paid to greenhouse gases, whose emissions can contribute to the process of global warming. To reduce them, airlines have, in fact, only two options. The first is to increase the growth of fuel efficiency (i.e., specific fuel consumption). The second is the use of alternative fuels: synthetic fuel from coal, natural gas, or biomass. Natural fuel does not contain sulfur and aromatic hydrocarbons, which significantly reduces the emissions of volatile aerosols and cloud condensation nuclei, thus reducing the impact on the radiation balance. In addition, model experiments have shown that the application of fuel purified from sulfur leads to a significant ecological "recovery" of the troposphere in terms of concentrations of ozone, sulfates and nitrates . it Should be noted that the attitude of experts to biofuels (produced from corn, soy, rapeseed, palm oil, algae, etc.) is far from unambiguous in conditions when crops often die due to droughts or untimely rains. Experts warn that a complete transition to biofuels threatens the gradual destruction of tropical forests and the rise in the price of food. Besides, when applied in the long term, the effect of reducing CO2 emissions has not been proven. Nevertheless, biofuels for aviation are already produced in the United States, Great Britain, Germany, France, and Finland. By 2020, China, which has established the production of fuel from palm oil, also intends to increase the share of biofuels to one-third of the total fuel used by aviation. In recent years, a number of countries that advocate for the environment have been actively replacing traditional aviation kerosene with cryogenic fuel (hydrogen, liquefied natural gas). When using it, the aircraft becomes more economical (fuel consumption is reduced), and CO2 emissions into the atmosphere are reduced.

According to various estimates, aviation emissions of carbon dioxide make up from 2 to 2.5 % of the total amount of anthropogenic CO2 emissions into the atmosphere. When burning 1 kg of aviation kerosene, 3.16 kg of CO2 is released. It is assumed that by 2040, with an optimistic forecast associated with improving fuel efficiency technologies, the amount of aviation CO2 emissions can reach almost one and a half thousand megatons per year. In 2016 CAEP recommended two new standards: on emissions of carbon dioxide and non-volatile suspended particles. The recommended CO2 standard is proposed to encourage more efficient fuel combustion technologies in aircraft production and is similar to existing standards for emissions and aviation noise. The standards will apply to models of a new type of subsonic and turboprop aircraft, which will be put into operation from 2020, and to those already in operation-from 2023. If operational models that do not yet meet the requirements for CO2 standards cannot be properly modified before 2028, then they will not be able to be used after this period. Emissions will be regulated using the proposed Global system of market measures. Exceeding the emission quotas (for the base level, it is planned to accept emissions in 2019 and 2020) will be subject to a significant fine, which will be used for environmental restoration and compensation measures. This approach to emission quotas is not new; it has been used in the EU countries since the early 2000s. For example, in April 2014, Germany issued fines for exceeding emission quotas by 2.7 million euros to 61 airlines from Russia and other countries, 44 of which were based outside of European territory. New standards for CO2 emissions will be set out in a completely new the third volume of Appendix 16 "environmental Protection" during 2017 The recommended standards for non-volatile particulate matter (nvPM will apply to engines manufactured from January 1, 2020. A full description of the certification procedure for measuring nvPM, as well as restrictions on their mass concentrations, will be included as a separate Chapter in the second volume of Annex 16, aircraft engine Emissions.

In 2016, at the 39th Assembly of the ICAO Council, the Russian Federation presented its position on this issue in the working paper " clean development Mechanism for international civil aviation as an alternative to the system of market-based carbon compensation and reduction measures for international civil aviation (CORSIA)". It consists in the fact that civil aviation plays the role of one of the main engines of economic development of the ICAO member States, while remaining one of the most environmentally friendly modes of transport. In this regard, it is unacceptable that attempts are being made to impose an additional financial burden on the civil aviation sector through the introduction of a Global market-based mechanism under the slogan of combating climate change. The diversion of Finance from the industry provided for by these Global market measures will have a negative impact on the pace of development of civil aviation and flight safety. At the same time, there will be no improvement in the volume of greenhouse gas emissions, and according to some calculations, the emission will even increase. This will have a negative impact, first of all, on countries with developing economies and the aviation industry.

5.3 Electro-magnetic contamination

In addition to noise exposure, aviation leads to electromagnetic pollution. Electromagnetic pollution (EMF of anthropogenic origin or electromagnetic smog) is a combination of electromagnetic fields of various frequencies that negatively affect a person. Some researchers call the electromagnetic smog that has arisen and formed over the past 60-70 years, one of the most powerful factors that negatively affect people at the moment. This is due to its virtually round-the-clock impact and rapid growth.

Electromagnetic pollution depends mainly on the power and frequency of the emitted signal. It is caused by the radar and radio navigation equipment of airports and aircraft, which is necessary for monitoring aircraft flights and weather conditions. Radar devices emit electromagnetic energy streams into the environment. They can create high-intensity electromagnetic fields that pose a real threat to people.

At civil aviation airports, the electromagnetic environment is mainly determined by the radiation of powerful radar stations. These primarily include ground-based surveillance radars operating in the ultra-high and ultra-high frequency bands. The effect of the electromagnetic field on a person in the areas where these stations are located is intermittent, which is due to the rotation period of electromagnetic radiation. Studies have confirmed the possibility of using computational methods for preliminary assessment of the electromagnetic environment around radar stations. The results of a survey of the electromagnetic situation in the area of a number of airports in the country showed that in 60% of cases, special measures were required to protect the population near the localities located, which were implemented. There are also national and international hygiene standards for EMF levels, depending on the range, for residential areas and workplaces.

Being in an area with elevated EMF levels for a certain time leads to a number of adverse consequences: fatigue, nausea, and headache. If the standards are significantly exceeded, damage to the heart, brain, and Central nervous system may occur. Radiation can affect the human psyche, irritability appears, and it is difficult for a person to control himself. It is possible to develop difficult-to-treat diseases, including cancer.

CONCLUSION TO PART 5

According to the topic of the thesis, it can be concluded that the fuselage sealing profiles have a minimal impact on environmental pollution. In turn, the impact of aviation on the climate and ecology may eventually become noticeable due to increasing air traffic, leading to an increase in pollution in the upper troposphere. The international civil aviation organization takes measures to reduce the negative impact of aviation on the environment. For this purpose, new standards are being developed that tighten the requirements for aircraft noise and emissions, and the list of aviation emissions for which aircraft engines are certified is being expanded.

GENERAL CONCLUSION

The work was devoted to solving the problem of selecting sealing profiles for transport aircraft in order to ensure the necessary safety conditions, quality of operation and maintainability. For this purpose, tests were carried out during which the mechanical properties of samples of different configurations were tested and the samples were determined that satisfy the necessary conditions. These results can be used in the selection of the necessary equipment for installation in the mechanization of the fuselage to ensure the necessary characteristics and ensure flight safety. Through experimentation, it was determined that the G4 sample under test showed results that are consistent with the operating conditions that the profile will be in after installation. So, the breaking rate of 75.1 kgf is the best and closest to the reference sample. Friction tests, which determine the tenacity of the profile and the level of its sliding along the plane in which it will be used, are also satisfactory. The elasticity values under different conditions, which simulate the pressing of the profile when the mechanization is in the closed position on the G4 sample, are high and the sample passed the test successfully.

Sealants that are used to secure the profiles to the surface must also meet all necessary criteria and must pass pull-off tests. During which it was determined that the Dowsil sealant has the highest peel rate equal to 23.6 kgf which meets the required criteria and all the necessary conditions for successful operation can be provided.

These studies demonstrate high quality and performance indicators of the selected models of sealing profiles, as well as the way they are fixed to the surface. Thus, we obtain a reliable assembly of parts for the mechanization of the fuselage, which can ensure high flight safety, maintainability, wear resistance, as well as high performance during operation.

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