Topic № 2
TEXTILE TECHNOLOGIES: SPINNING, WEAVING AND KNITTING

677
Textile Industry.
Technology of textile materials.

Youth revue: collection of Iva Georgieva and Joe Macchi the
Fashion Design Department at the National Academy of Fine Arts Sofia

Youth review: a collection of the Department Design and Technologies for
Clothing and Textiles at SWU Neofit Rilski with authors Milena Perchinkova and Yuliana Dimitrova

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STUDY OF THE DESIGN OF COMPONENTS FOR PERSONAL BALLISTIC PROTECTION (PBP) SYSTEMS USING CAD/CAM/CAE SYSTEMS

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The development of science and manufacturing technology tied to the introduction of innovation is the continuous drive to develop the world's armies, a process that involves daily projecting, research and experimentation, fortunately modern technology allows many of the processes to be designed and simulated virtually before any item is physically created.

Digital prototyping with CAD systems of a specific item of personal ballistic protection equipment allows the creation and study of the entire product before it is ever manufactured (Figure 1). With CAD systems, digital prototyping could easily be implemented by integrating 2D drawings and 3D data into a single digital model. This model is a virtual representation of the final product and helps engineers to design better and more efficiently. This significantly reduces development costs and time to realize new products.

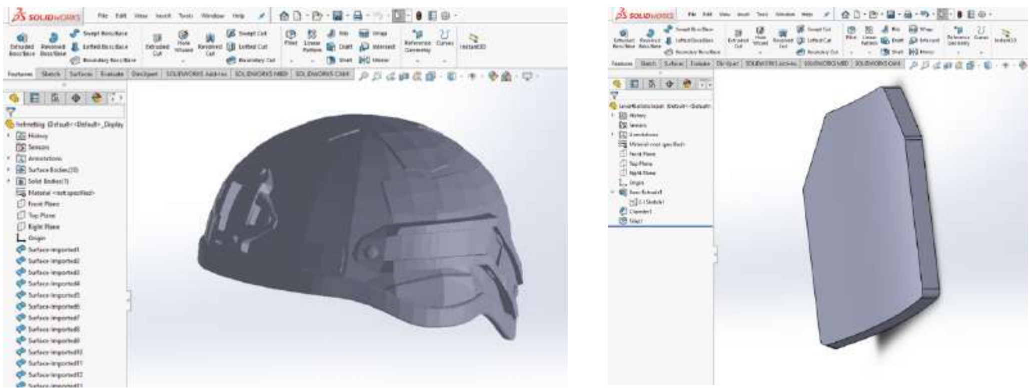
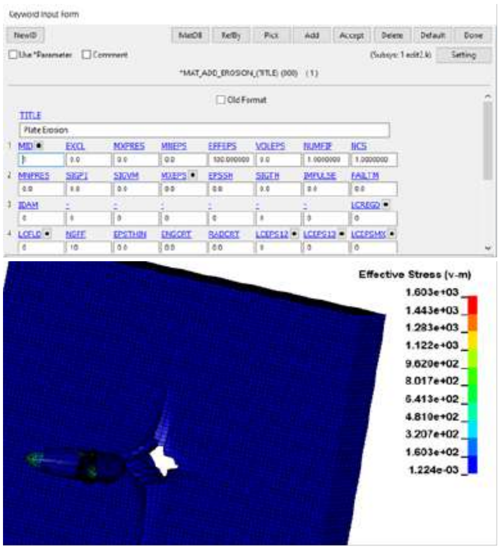


Fig.1. 3D models of combat helmet and armoured plate (SolidWorks)

In physical research, it is necessary to use n number of functional models of the existing or future product due to the need to collect sufficient data to draw valid conclusions. There is also the 'black box' effect, which is characterised by the fact that there are a large number of variables in the experiments that can influence the results and make it very difficult to understand the final outcome (need for technical means, technological systems to change geometry and mass characteristics, place to conduct the study, etc.).

On the other hand, virtual analyses implemented by CAE (Computer Aided Engineering) products (Fig. 2) provide almost unlimited possibilities to study an object and simulate it in the desired environment. These possibilities to consider a large number of indicators determine the "white box" effect that occurs precisely in virtual studies. Another plus in these analyses is the elimination of the need for physical prototypes of the object under study, as well as the possibility of immediate optimization in the models when analysing previous results. For the construction of this type of studies, good computational power and experience in the field are required in the creation of the mathematical model and the correct interpretation of the results obtained.

One of the areas where there are numerous studies and the possibility of creating models for virtual studies is the production of personal ballistic protection components (ballistic panels and inserts for body armor, ballistic shields, combat helmets, etc.).



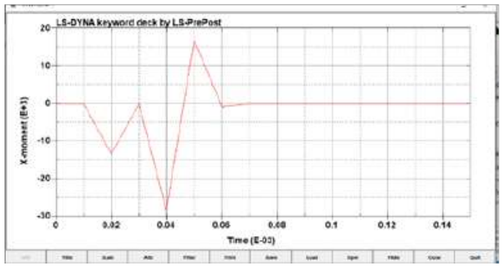


Fig.2. Input data input and result generation in virtual engineering (CAE), general-purpose multiphysics simulation software package LS-DYNA

In this regard, modern CAD/CAM/CAE systems could be successfully used for three-dimensional modeling of the individual elements of the individual ballistic protection means, from which the graphical part of the design documentation is prepared - the drawings, engineering calculations and analyses, rapid prototype preparation, technological preparation of production, preparation of control programs for machines with digital program control for the manufacture of different complexity of products entering the set, as well as for the overall management of the design

Keywords: CAD/CAM/CAE systems, personal ballistic protection, equipment, .

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USING OF FOAMS IN PERSONAL BALLISTIC PROTECTION DEVICES

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Introduction: Object of present publication are foams as a typical representative of materials, with ability to absorb kinetic energy, caused by the impact with bullet. In the publication will be analysed the possibility of choosing the most useful type of foam for the specific application in personal ballistic protection devices according to their technical parameters, without need to perform destructive tests with shooting.
Experimental part: Is made a comparative analysis of 12 different types of foams. In the analysis are included technical parameters also the results of measuring water absorption and trauma by shooting of ballistic system with ammunition.
The measurement of the amount of water absorption was carried out by weight method before and after immersion in water.
The shooting tests were carried out under the same conditions for all samples of foam: with the same ballistic system (armor plate) - same ballistic material with the same number of layers laminated to each other. To the back of the plate is bonded the test sample of the foam. The shooting was carried out with two bullets of the same ammunition - 7.62x51 mm FMG (full metal jacket) NATO, at the same locations of the sample.
Results and discussion: The foam with open cells is with the biggest water absorption – more than 200 percent above. This makes the foam highly unsuitable for use for ballistic protection, as the weight of the product will increase significantly in the event of rain or immersion in water. Also, have to be expected reduction in impact energy absorption, respectively the ability to reduce trauma, as well as the ability to protect the ceramic from cracking, by dropping from a height. The foam B50 shows the best potential for reducing trauma. B50 has the highest stiffness and deflection, and it is second in strength. No other parameter is noticeable that significantly distinguishes the foam from the others. At the same time, the BIL 1701 foam does not differ in technical parameters compared to the other foams, but it practically shows a reduction in trauma almost as with B50 foam. It is not clear the method of measuring the technical parameters noted in the table.
Conclusion: The research carried out - subject of this publication, shows that technical parameters are not enough in determining the applicability of foams in personal ballistic protection devices. This possibility will be the subject of new research and studies.

Keywords: foam, ballistic resistance, ballistic model, bullet resistance, trauma.

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STUDY OF PHYSICO-CHEMICAL AND MECHANICAL PROPERTIES OF WILLIAM CAVENDISH BANANA PEDUNCLE FIBERS

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Abstract

The banana plant is a monocotyledonous plant belonging to the Musaceae family (order Zingiberales), of which nearly 70 species have been discovered. [1]. It generates an enormous quantity of biomass, including the peduncle, which is a potential source of fiber. [2].

This is the part of the banana plant that supports the inflorescence and links it to the rhizomes and fruit. To the best of our knowledge, no work has been carried out on the possibility of using this biomass in the textile sector in Cameroon.

The aim of this work is to study the physico-chemical and mechanical properties of WILLIAM CAVENDISH banana peduncle fibers for use in the textile industry.

According to the literature, several researchers have carried out studies on the extraction of fibers from banana peduncles using various methods, and on their recovery. Based on these studies [3-13], in this work, three different modes of extraction have been carried out.

The peduncles were obtained from the production residues (waste) of the PHP Company located in the Littoral-Cameroon region, Mungo Department and Njombe Penja District. Prior to extraction, the green skin is removed, using drums and tarpaulins for display, followed by biological retting with water, in the dew and mechanical extraction.

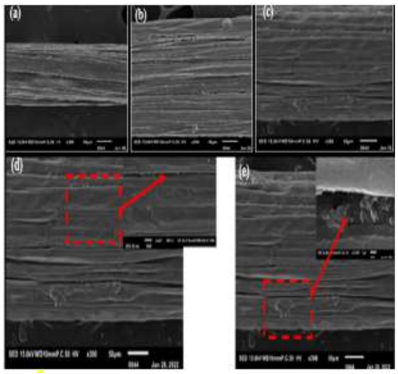
The equipment used for the physical characterization of William banana peduncle fibre (FHBW) is as follows: a mesh meter for length distribution, 100ml pycnometers for density determination; a thousandths balance for weighing; colour assessment using the Datacolor device; the JEOL JSM-IT100 for SEM observation; the VIBROMAT ME and the Projectina for the measurement of fineness and apparent diameter respectively. With regard to chemical properties, the Van Soest dry biomass fractionation method was used to determine cellulose, hemicellulose and lignin content; the Infra-Red was determined using a BRUKER IR Spectrometer; the NETZSCH STA 449F3 ATG and the X-ray diffractometer were used to determine the thermal stability and the amorphous and crystalline fractions of the FHBW respectively. With regard to the mechanical characterization of FHBW, the tensile test was carried out using the MTS and the flexural test using the KAWABATA module.

The fibers were extracted by three methods and the fiber yield assessed. The results show that water retted fibers have a higher yield compared to dew retted fibers and fibers extracted by lamination. According to the Barbe and Hauteur length analysis, the retted fibers show a good balance with few classes of long and short fibers and a large class of medium fibers compared with the laminated fibers.

SEM observation shows that the fibers extracted by the three methods are in the form of fibers bundles. The fibers extracted by lamination still contain pectin's, in contrast to the visibly smooth fibers extracted by retting. [11]. The longitudinal structure is in the form of small flat ribbons, whatever the extraction

method.

As far as cellulose is concerned, it can be seen that extraction methods do not have a major influence. On the other hand, the cellulose content of laminated fibers (74.8%) is higher than that of fibers retted in the dez (73.6%) and in water (71.8%). These cellulose contents are higher than those of Musa acuminata peduncle fibers found in the literature[11].



From the various thermograms obtained, we can see that WBPF are thermally stable up to 82°C. We can conclude from this result that fabrics made from these fibers can be ironed at temperatures below 82°C.

The diffractograms at show that the crystallinity index of the fibers extracted by lamination is more significant (69.53%) than those obtained with water- and dew-retted fibers (58.24% and 54.83% respectively). This low value may be due to the presence of non-cellulosic substances on the fibers.

Looking at the tensile curves, we can say that the extracted fibers have a behavior close to linearity with little viscoelasticity, whatever the extraction method. This type of behavior should lead to rather brittle fractures.

Analysis of the fracture surfaces of the extracted fibers reveals a hollow fiber structure, composed of small, thin-walled, juxtaposed tubes. The facies confirm a brittle fracture mode; the brittle nature of plant fibers has been demonstrated in the literature by Maria et al.[12].

Similarities were observed between the tensile and flexural mechanical properties of fibers obtained by spinning.

The tensile test shows that the fibers retted in the field have lower values than the others; the tenacity of the laminated fibers is higher (58.83 cN/tex) than that of the other methods; however, it is still in agreement with the results of the chemical composition, while the flexural analysis shows that the laminated fibers are stiffer than the retted ones. in comparison with the literature, the tenacity of William banana peduncle fibers is higher than that of flax and sisal fibers, which means that these fibres can be used in textiles [13].

The flexural stiffness values for the different fibers lead to the conclusion that the retted fibers are less stiff than the fibers obtained by lamination.

From the results presented, it can be said that William banana peduncle fibers extracted by the three methods are suitable for textile applications. However, the laminated fibers could be softened for better exploitation.

Keywords: William banana peduncle fiber, physical-chemical and mechanical properties, SEM

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POTENTIAL ENERGY EQUILIBRIUM OF THE ELASTIC DEFORMATION IN THE TWISTED FIBROUS SHEAF

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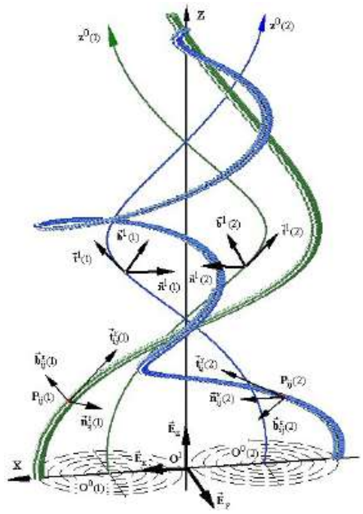
The initial equilibrium state of the fibrous sheaf is straight parallel fibres without deformations and stresses, with a negligible level of elastic energy. The cross-section of the sheaf is close to a circle, in which the fibres are uniformly arranged, and after twisting, each fibre acquires a spiral shape.
The strength-strain process is carried out alternatively by 2 independent arguments: the strain or stress, displacement or force. In the present study, the externally applied argument is deformation, i.e., the relative elongation ε along the axis of a fibrous sheaf of twisted fibres - thread.
Integrated over the h-height of a thin plate of the sheaf cross-section, the relative elongation acquires metric displacement dimensions: $h\_i=\varepsilon$. Each of the fibres in the already twisted sheaf has a static shape that orients the axes of the local coordinate system. The same for all fibres displacement hi along the axis of the sheaf is projected along the axes of the local coordinate system $\Omega\xi\eta\zeta$ of each fibre. The local projections lead to 3 linear and 3 angular displacements: longitudinal and torsion along the ζ tangent, shear and bending about the normal ξ and about the binormal η. Referred to the orthogonal surfaces of the fibres cells, the projected displacements are distributed as elements of the strain tensor $\underline{\underline{\varepsilon}}$. The natural values of Young's modulus and Poisson's ratio give the linear relationship between applied strains and induced stresses $\underline{\underline{\sigma}}$ on the fibre cell walls. The components of strains and stresses make up the total potential energy field of elastic deformation. Conversely, the integral, generalized sum of stresses from the stress tensor $\underline{\underline{\sigma}}$ on the cell walls gives the unit effort of each of the fibres and finally the elastic resistance of the entire sheaf.



When visualizing the computational model, the elongation and reaction of the fibrous sheaf represent the coordinates of the analytical rheogram of the strength-strain process.
The strain-stress equilibrium of the elongated thread is due to the distribution of uniaxial elongation into unit displacements along all fibres and the redistribution of unit displacements into multi-component linear and angular strains in the fibril structure of the fibres. An equilibrium evaluation is the calculated value of the potential energy of the elastic deformation.
Subject of this paper is the equilibrium between the uniaxial elongation of the thread and multi component efforts of the fibres in the fibrous sheaf.
The purpose of the development consists in the creation of a computing device for determining the elastic resistance of textile threads and visualizing the analytical model of the strength-deformation process.

Keywords: textiles, fibrous sheaf, stain-stress tensor fields.

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MILITARY CLOTHING IN THE BULGARIAN ARMY – PAST, PRESENT AND FUTURE

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The introduction of a uniform in the Bulgarian army makes it possible to clearly distinguish the servicemen from the civilian population; to emphasize: national identity, belonging to a certain kind of army and social status. The military uniform allows the servicemen to be maximally protected from various climatic features while performing their military duty.

The development of science and technology makes it possible for military clothing to be developed from innovative materials, meeting the increasingly high needs for the protection of military personnel.

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REQUIREMENTS FOR THE FABRICS AND MATERIALS SUITABLE FOR THE CONSTRUCTION OF MILITARY UNIFORMS

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Military clothing should allow for activities that are often physically demanding while providing protection, information superiority, and maintaining capabilities, durability, and mobility, protecting them from environmental threats, reducing impact, and providing them with all the functionality they need. In the context of increasing world conflicts, the question of how well people are protected on the battlefield remains increasingly important. Recently created military conflicts require measures to be taken that can secure the protection, communication, comfort, and guarantee capabilities of everyone involved in national and global security. In this context, of particular importance is the introduction of smart and multifunctional textiles, a new generation of materials and systems with multifunctional properties that, given their ability to be integrated into uniforms, have attracted the attention of the defense community. Smart textiles are defined as textiles capable of interacting with their surroundings: they react and adapt to a given stimulus. Functional textiles provide an additional and specific function through their composition, construction and/or finish. Typically, these features include increased mechanical resistance, water and/or dirt repellency, fire retardancy, antibacterial properties, protection against UV, pests or chemicals, thermal insulation, etc..

Smart and multifunctional textiles pave the way to multiple possibilities for developing high-tech garments that meet multiple needs in an elegant solution. These materials allow the integration of various components and devices in a convenient and ergonomic way, providing a wide range of functionalities. In addition, these textiles also offer new opportunities for integration with platforms and systems.

An example of a challenge associated with physically demanding work in harsh environmental conditions is managing heat stress. Uncompensated heat stress can lead to loss of physical and cognitive performance, as well as life-threatening heat-related illnesses. The main reason is the conditions specific to military service: The soldier is a hard physical job, often in protective clothing due to complex threats (e.g. ballistic vests, ballistic protection equipment), whose insulating properties are of great importance, especially in areas with hot climates.

Another key challenge in the defence context is to ensure that soldiers have the best chance of survival through prompt and life-saving medical treatment when they are seriously injured in a military conflict or combat situation. With a large number of seriously injured soldiers, a rapid and accurate assessment of the critical status of the wounded is necessary to calculate the number and priority of treatment by emergency physician triage. If vital signs such as pulse, blood pressure, oxygenation, and electrocardiogram can be determined quickly and transmitted by the casualty using portable sensor systems wirelessly to the emergency physician who performs the triage and first medical treatment, the efficiency of care and the chance of survival can be improved.

Smart and versatile textile materials also propose the opportunity to provide additional functionalities that will have a major impact on soldier safety, performance and well-being. The soldier of the future will need technological solutions to detect and monitor information coming from both his surroundings (such as threats) and his physiological state (parameters related to the soldier's experience of stress and his state of health, etc.) Another important aspect is the ability to know his location with a high degree of accuracy, and to be able to receive and provide information related to his current state.

Smart and multifunctional textile materials allow the integration of various components and devices into uniforms and military systems and extend the range of their functionalities. To address challenges such as those listed above, functions may include environmental and soldier physiology monitoring, localization, communication, energy management, and protective functions (e.g., environmental protection, signature reduction including thermal radiation, fire protection, electromagnetic radiation protection, and neutralization of hazardous chemicals).

Textile materials for military uniforms in the foreseeable future must provide the ability to distribute, provide/convert energy and/or store energy to support some of the above functions.

Keywords: Smart and multifunctional textiles, military clothing.

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DEVELOPMENT OF POLYMERIC BRAIDED STENTS

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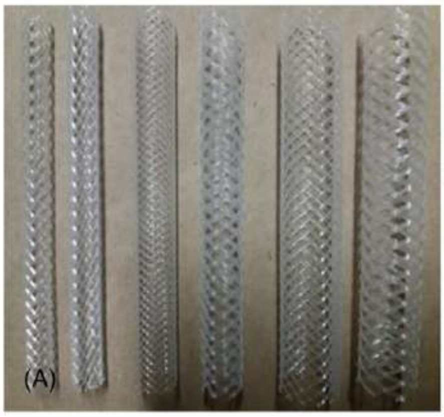
Metallic stents have been largely used over the last decades to treat vascular diseases like coronary artery or peripheral vessel stenosis. Although they remain the gold standard for vascular treatment, they are subjected to in-vivo complications such as corrosion, structural failure, fractures, and re-stenosis due especially to the material which is used. Polymeric stents were developed as an alternative to replace commercial metallic ones presenting several failures caused especially by the used metals. Among those materials, the polyethylene terephthalate (PET) have been used to develop stents since PET is suitable for several biomedical uses such as vascular prosthesis. Braiding technique was used since it provides flexible structures. In this paper methods and materials for the development and characterization of PET braided stents were given and the main results were highlighted.



Results bring out that PET braided stents show very promising structural and mechanical performances comparing to metallic stents. They guarantee in particular a good flexibility and stability to cyclic loadings predicting their long-term behavior. As a conclusion, PET-braided vascular stents show a huge potential to replace commercial stents but their manufacturing parameters should be carefully chosen. Despite advances in cardiovascular stent materials and designs to decrease post-deployment complications, starting from the "Wallstent" implanted in 1986 until today, problems such as corrosion, structural failure and fractures causing inflammation, early thrombosis and in-stent re-stenosis are still existing. These complications are mainly due to the metallic material used as well as to the structure itself, more precisely, to a poor tolerance of the organism to their long-term presence, to an excessive rigidity causing a high mechanical stress on the vessel wall, to a lack of flexibility especially in tortuous arteries or to a low resistance to fatigue caused by in-vivo cyclic displacements due to the blood flow, etc. For this, stents are classified by the European authorities as the most implantable medical devices showing important risks of local and general complications after implantation. Research is advancing on all fronts, especially towards the use of other materials. Among the solutions that could be promising in reducing complications related to commercial stents, several research groups developed and characterized polymeric vascular stents, braided or knitted, using non-biodegradable polymers such as polyethylene terephthalate (PET), polypropylene (PP), polyurethane (PUR), polyamide (PA), etc. From the results, PET-braided stents are found to be the best candidates to replace metallic stents. This study gives a review about polymeric non-biodegradable stents, and then summarizes and discusses the main findings about PET-braided vascular stents.

Keywords: Polymeric stents, non-biodegradable, PET, braiding.

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COMPOSITION OF WORKING PROCEDURES AND INSTRUCTIONS FOR THE QUALITY OF RAW FABRICS

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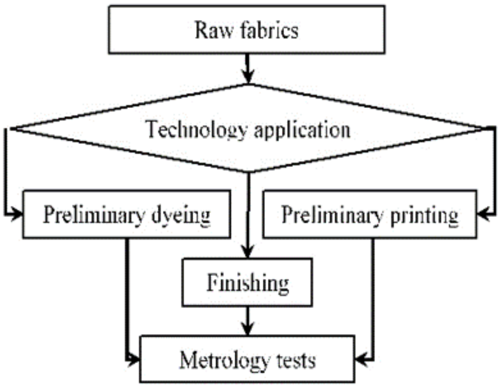
Raw fabrics can be patterned in three different ways: dyeing the fibers before weaving; dyeing after weaving; printing after weaving. The problem that will be considered in the development is that different fabrics have different technical characteristics and different technological processing.



Fabrics that are designed at the level of fiber dyeing are subject to further technological processing, which includes only the processes of refinement - washing, fixing and relaxation. The other part of the fabrics, which are woven or knitted before the threads are dyed, are subject to dyeing, by applying dye in a dye bath or applying a pattern to the textile material by means of transfer or direct printing. For this reason, the working procedures for the quality of raw fabrics are compiled in a hierarchically constructed algorithm and carried out by corresponding instructions.

The instructions contain a set of ordered laboratory tests in accordance with standard sampling and testing methods. The instructions are graphically presented as A5 or A6 size labels and accompany the specimens through the series of tests.

The first testing procedure to which the fabrics are subject consists in checking the main parameters - width and area mass. Subsequently, we move on to determining the structure and fiber composition of the textile surface product - the thread densities, linear density, warp and the composition of the threads in the fabric are examined. The next stage of the work procedures is the determination of the mechanical resistance of the fabrics - strength to breaking or cracking strength and surface friction resistance. Depending on dyeability, fabrics are test dyed to determine dye affinity and possible unevenness in bath dyeing and printing.

Different variants of working instructions are outlined, which are accompanied by different laboratory activities.

Work procedures are implemented in the daily production activity through instructions that aim to guide the activity of the laboratory and quality control, with the aim of reducing the consumption of test samples and laboratory activity.

The subject of this article is the compilation of procedures and instructions for quality control of raw fabrics within the BDS EN ISO 9001 quality assurance system.

The aim is to draw up rules and strengthen quality control activities.

Keywords: fabrics, quality control, work procedures and instructions