COMPREHENSIVE CHARACTERISTICS OF THE GEOMETRIC STRUCTURE OF SURFACE OF WOVEN FABRICS WITH DIFFERENT CONSTRUCTION

(KOMPLEKSOWA CHARAKTERYSTYKA GEOMETRYCZNEJ STRUKTURY POWIERZCHNI TKANIN O ZRÓŻNICOWANEJ KONSTRUKCJI)

ABSTRACT

The aim of work was to extend the existing knowledge and acquire new knowledge in the field of the geometric structure of surface of the woven fabrics, the study of this structure and the impact of fabric constructional factors on the geometric structure of their surface.

As part of this work, systematic research was undertaken, allowing an assessment of the geometric structure of surface of the woven fabrics with a systematically diversified structure, as well as the assessment of the impact of the constructional parameters of fabrics on selected parameters and functions characterizing the geometric structure of surface. The fabrics were also tested in the range of abrasion resistance using the Martinale's test. The comparative study of the measurement of surface roughness by means of contact method – KES-FB4 and contactless method using the profilometer has been also performed.

The thesis of the work is as follows:

Measurements of fabric surface roughness using the contact method are insufficient to fully characterize the geometric structure of the fabric surface and to assess the effect of the fabric surface geometry on their performance properties, such as: wettability, abrasion resistance, heat absorption or light reflection. Non-contact tests using the optical method allow for a comprehensive characterization of the geometric structure of the surface of woven fabrics, as well as for the analysis of the relationships between the constructional parameters of woven fabrics and their selected parameters of the geometric structure of their surface.

In the doctoral dissertation, the research concerns the measurement of the geometric structure of surface of the woven fabrics using the contactless method - optical method with the use of the MicroSPy Profile® profilometer by the FRT. Research of this type is not yet widespread in the textile industry. The literature review first focused on the issues related to the geometric structure of the surface of various objects and methods of its measurement, and then a review

of scientific works on the measurement of the geometric structure of surface of textile materials.

In the presented work, the cotton woven fabrics with a diversified structure have been the objects of the investigation. The differentiation of the structure of the woven fabrics has been obtained by using different weaves, different weft density and different linear density of the weft yarns. Totally, 21 variants of the cotton woven fabrics have been manufactured and investigated. The fabrics being the subject of the analysis were made in 6 weaves. The fabrics were made on the basis of one warp of cotton yarn 50 tex OE (rotor, OE - Open End). Five types of yarns were used as the weft:100 tex OE, 60 tex OE, 50 tex OE, 40 tex OE and 30 tex OE. Six kinds of weave were used in the tested fabrics: plain, twill 3/1 S, twill 2/2 S, reap 1/1 (010), reap 2/2 (2) and hopsack 2/2 (020). In selected variants the weft yarns of linear density: 11/cm, 9/cm and 7/cm have been applied.

The measurement of geometric structure of surface of the manufactured woven fabrics was done using the non-contact, optical method, using the MicroSpy® Profile profilometer by FRT. In addition, comparative tests were carried out using the KES-FB4 device. The study of changes in the geometric structure of the fabric surface as a result of the abrasion process was also carried out. Abrasion test has been performed using a Martindale's apparatus. To analyze the measurement data from the profilometer, the specialized Mark III software, also from FRT, has been used. The statistical analysis of the measurement data has been carried out using statistical tools available in the TIBC Statistica software: correlation analysis, one-way- and multi-factor analysis of variance (ANOVA).

Theoretical considerations based on geometry of plain weave have shown that the complexity of the phenomenon and a large number of factors influencing the formation of the fabric surface make any mathematical/geometric modeling of the geometric structure of the fabric surface very complicated.

The obtained results and their analysis unambiguously confirmed that the basic structural factors of the woven fabrics: weave, weft density and linear density of the weft yarn in a statistically significant way, at the significance level of 0.05, affect the geometric structure of the fabric surface. The interaction between the weave, the linear density of the weft yarn and the weft density is also statistically significant.

On the basis of the correlation analysis, it was found that there is a strong and statistically significant correlation relationship between some basic and derivative parameters of the

structure of fabrics and the parameters of geometric structure of fabrics surface determined using the profilometer. However, in the case of the parameters *sRa* and *sRq*, there was no strong relationship with any of the structure parameters. What is surprising, and at the same time confirms the previously mentioned limitations of contact methods for measuring surface roughness of the textile materials.

The tests also confirmed that the MicroSpy® Profile optical profilometer by FRT, together with the specialized Mark III software, can be used for comprehensive measurement of the geometric structure of the surface of fabrics. It provides a range of detailed information on the fabric surface in the form of parameters of the geometric surface structure, histograms of the height of points on the surface, autocorrelation function, spectral density function, fractal dimension, distribution of tangent angles on the surface, material curve and many others.

Based on the tests carried out and the results obtained, it can be concluded that the measurements of the geometric structure of the woven fabric surface using the non-contact, optical method make it possible to assess changes in the structure of the surface subjected to the abrasion process using the Martindale's device. After 10,000 abrasion cycles, changes in almost all parameters characterizing the geometric structure of fabrics were observed. Depending on the parameter, the values have increased or decreased. The results showed that the profilometric measurement can be applied in practice to assess the abrasion resistance of the woven fabrics. However, the method and parameters requires further research and in-depth analyses, e.g. using a different number of abrasion cycles and assessing other changes in the abraded samples, e.g. loss of sample mass after abrasion, and referring these values to the values of the parameters of the geometric structure of the fabric surface.

Summing up the research carried out and the conclusions drawn from them, it can be said that the thesis of the PhD work has been fully confirmed.