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DEVELOPMENT OF A NEW EXAMINATION METHOD OF THE COEFFICIENT OF FRICTION OF TEXTILES

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Abstract:

Nowadays, the importance of technical textiles is more and more on the increase, they have become an almost indispensable part of our lives. For the more efficient use of textiles it is important to know their friction properties, within this the changes of their coefficient of friction on different surfaces and under different conditions.

There are several known methods to determine the friction and the coefficient of friction of textiles and textile structures (textile, yarn, filament fibre). In the present article those methods and testing procedures are summarized with the help of which these important properties can be determined, and the new test method developed in the textile test laboratory of Óbuda University is presented.

The new development makes it possible to simultaneously examine both forces of friction, i.e. kinetic (sliding) friction and static friction in case of all textile structures. With the help of this development the coefficient of friction can be examined on „any" surface, even on another textile structure, and the force of friction can be measured on two different surfaces simultaneously.

Keywords: *technical textiles, coefficient of friction, textile structures, Euler formula*

1 INTRODUCTION

The mechanical characteristics of the products of light industry depend on the external characteristics of raw materials (treads, fibres). In the case of flexible textile products, clingfilm or other felted, flatted materials the specific surface and its feature of friction role can be highlighted.

Friction is significant in every process of textile industry. At the very beginning, friction between raw fibres is essential for the yarn manufacturing. Friction is not only indispensable in the preparatory process, but exceedingly influences the physical and functional features of fibres and textiles e.g. the feel of the textile, which subjective attribute is conditioned by the friction features.

Industrial textiles are increasingly important they become integral part of everyday life form fashion through construction and health care till machine industry. [1], [2]

2 The methods of determining the friction and the coefficient of friction of textile structures.

Friction factor (μ) is an empirical quantity, a correlation number without dimension dependent on the material of the touching surfaces. In the case of two given surfaces the friction coefficient can have two values depending whether surfaces are moving . The stationary friction coefficient (kinetic friction coefficient) or they are standstill stationary friction coefficient is usually greater than the kinetic one. The problem has been discussed by several scientists thus there are more than one solution and method to determine them. The friction coefficient of textiles is not easy however, its value is substantial. E-creating structures of fibres and textiles or considering the attrition of industrial textiles (canvasses and

hold fasts). The task has its own difficulty because of flexibility, since textiles can bend to every direction of space
Friction coefficient can be determined by the Coulomb method or the Euler formula.

Friction determination according to Coulomb formula on plane

If two bodies touch each other and they move comparing to each other force of friction is created. Its formula was discovered by Charles Augustin de Coulomb (1736 – 1806) first.

$$S = \mu \cdot N \tag{1}$$

S - force of friction[N]

N - normal force i.e. the force perpendicular to the surface and the force, which compresses the two bodies [N]

μ - Friction factor [-]

Friction determination according to Euler on cylindrical surface.

This formula can be applied in the case of fibres, textiles and other flexible materials very well i.e. the examination of force of friction and Friction factor.
These relations were introduced by Leonhard Euler (1707–1783).

$$F_\alpha = F_0 e^{\mu\alpha} \tag{2}$$

F_α – force of pulling [N]

F_0 – force of preloading [N]

μ - Friction coefficient [-]

α – Encircling angle [rad]

The following methods are used on the basis of the formerly mentioned formulas

I. on plane according to Coulomb's formula:
   - adjustable slope
   - horizontal plane

II. on cylindrical surface according to Euler's formula
   - between stationary fibre and rotating fractioning body when two parameters are unchanging (unchanging parameters are encircling angle and pulling force in one branch
   - between stationary fibre and swinging fractioning body when two parameters are unchanging (unchanging parameters are encircling angle and the vector sum of forces which

- between moving fibre and stationary fractioning body
- when one parameter is unchanging.
- when one parameter is unchanging with measuring springs

During the examinations frictions between textile and textile or between textile and fibre can be measured. Friction can be affected by other factors than the raw material and the surface material e.g. the structure of the textile (weaving) examination direction of the material (chain … kind of α angle. Variables can be studied in different combination. [3], [4], [5], [6]

3 set which has unchanging angle and which is unchanging prestreching and cylindrical.

According to scholars it seemed the best when friction features of any flexible textile structure can be measured by the same setting in the same circumstances.

Description of the studying method:
The chosen process and the structure of the basic machine set the measuring appliance.
The frictions of the sample bodies were examined in the laboratory of Óbuda University Faculty of Light Industry and Environmental Engineering The measuring appliances were also developed there.
The aim of the study is to determine the stationary and kinetic friction features of chosen textile structure. By this development the stationary and kinetic friction force can be defined during the same measuring cycle with the same settings.

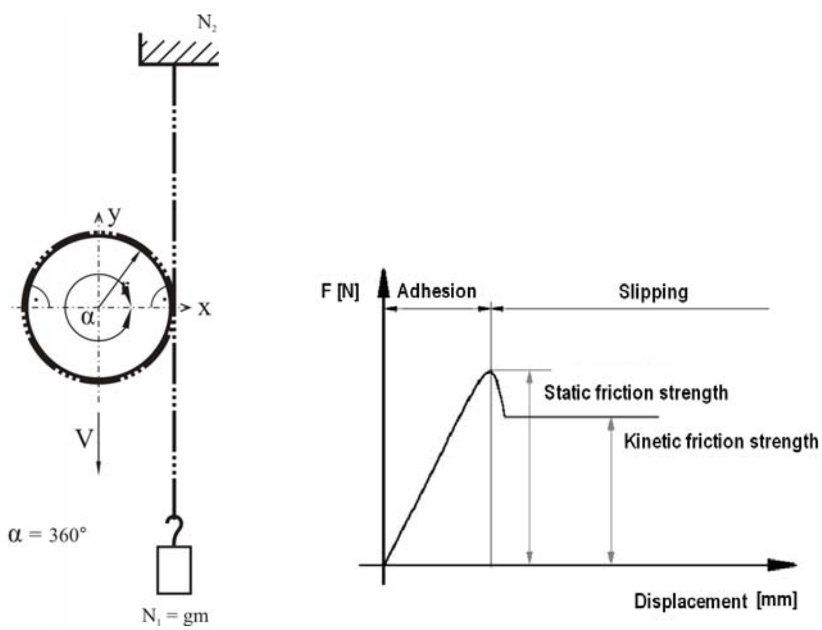

Figure 1: Cylindrical setting and examination graphics.

The basic of examination was the setting of 360^0 encircling grade
During the measures forces of friction can be determined thus the friction coefficient can be calculated.
The 1st illustration reveals the lateral view of the cylindrical body, which can be substituted with any other surface. The textile, which is to be examined, should be put on to the fractioning body. One end of the sample should be fastened at N_2 the N_1 weight will be put on the other one.
Having N_2 been increased it will exceed the value of adhesion friction then the sample will slide on the body and it will begin to move.

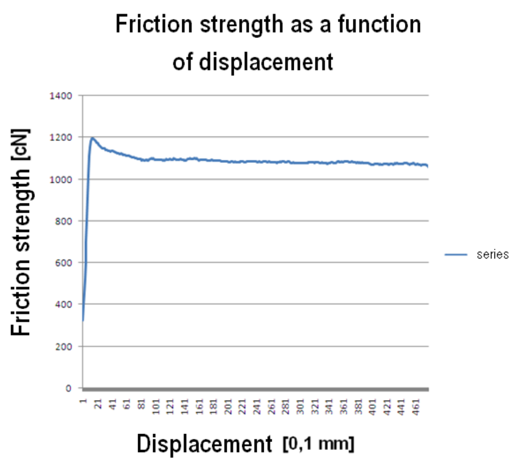

Figure 2: friction strength plotted as a function of displacement (Astra industrial sewing thread (100% polyester) – Polyamide friction test

The graph describing the examination will provide exact data about both stationary and kinetic friction factor
The friction factor can be determined by the following formula:

$$N_2 = N_1 \cdot e^{\mu \cdot \alpha} \qquad (3)$$

N_1 – pulling force [N]
N_2 – preload [N]
μ - friction factor[-]
α - encircling angle [rad]

The extraordinary advantage of the examination is that during the test of the sample one graph can determine both stationary and kinetic friction factor.
For the measures Fm-27 type electrical fibre tearing machine was used. The machine is a vertical tearing set vertical with a pulling spindle, electromechanically controlled, which can be seen in picture 3.

Figure 3: Fm-27 type electronic single fibre tensile tester

The tearing mechanism is on the right side and the examining cylinder was applied onto the pulling head console of the aforementioned machine. During planning a solution emerged which allowed to change of the friction body (cylinder). The change of the cylinder provides opportunity to bodies of different surface and different surface ruggedness and different diameter be examined.

The solution in picture 1st did not allow examining friction of wide samples of textile. The angle of 360^0 grades depending on the width created torsion by this the original setting was modified. At the one cylinder method another complication emerged: the interference of ends of samples. This made the measures dubious. Usage of textile covered cylinders caused extra difficulty, because overlapping covers hampered smooth laying of sample and exact measuring which is depicted on the 4th illustration.

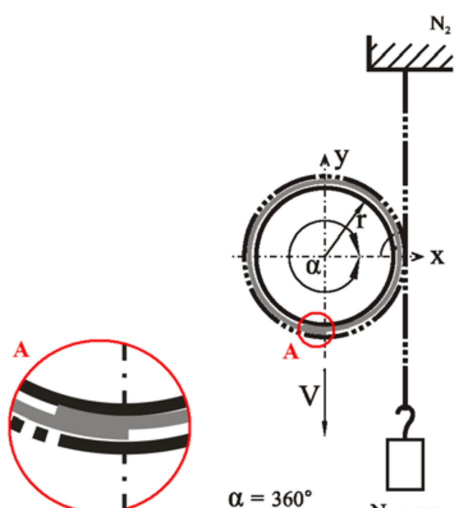

Figure 4: A cylindrical measuring appliance with a friction body covered by textile.

4 creating a double cylindrical measuring appliance

The double cylindrical solution provides with the opportunity for that the examined textile may be laid on the body without torsion. Furthermore the width of the sample can be as wide as the cylinder. By the double cylindrical solution the overlapping can be avoided because the rotating angle is 180 grade thus there is enough room for the overlapping as the 5th picture demonstrates.

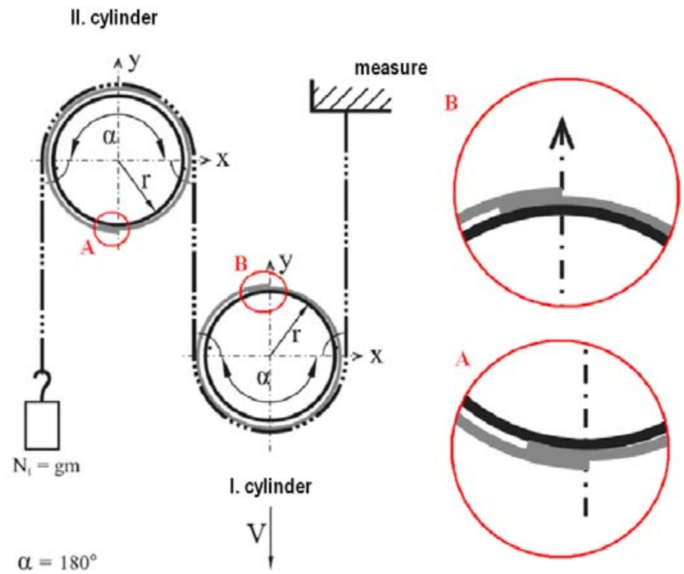

Figure 5: Double cylindrical examining appliance covered by textile

The adjustability interchangeableness was paid attention to when planning the appliance (Figur 6). The holding console of the IIth Cylinder was fastened to the framework of the tearing machine so the cylinder was fixed regarding to the "y" axis. The shape of the holding console has the form of a fork so in the case of different cylindrical diameters or covering materials of different thickness the 180 grade can be granted by the correct setting on the "x" axis.

Figure 6: Double cylindrical forming

Comparative studies prove that double cylindrical measuring solution produces the same results as the mono cylindrical does as it is illustrated in the 7th illustration. The diagrams of mono and double cylindrical solutions cover each other most of the time. So dicing 360 degrees into two 180 degrees (180 grade for each cylinder) does not alter the results.

The advantage of this new style double cylindrical arrangement is that the friction force can be measured simultaneously on different surfaces so the co-effect of two different surfaces can be examined.

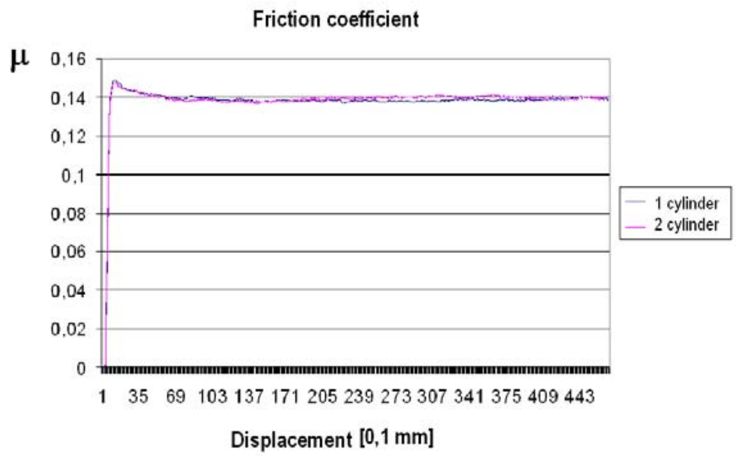

Figure 7: Comparison graphic of friction factors Astra industrial thread (100% polyester) Polyamid friction test

5 SUMMARY

In the present article the elaboration of a new examination method based on known principles was dealt with. The bicylindrical measuring method facilitates the measuring of friction and the coefficient of friction of textiles and textile structures (such as textile,, yarn, filament, fibre) and the exact determination of values measured on different surfaces at the same time.

The methods and procedures applied so far were presented. The principle of the measuring method was described, as well as the practical application of the principle taking into consideration the available possibilities. The steps of eliminating problems emerging in the course of realization were also presented.

The one cylindrical measuring method (witch works on the Euler formula) was developed into the two cylindrical method. It was verified that the new solution does not change the essence of the measurement, and it has further techniqual advantage.

Further research of the new development is planned, opening up possibilities of detailed exploration of further application of the method.

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