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Study on the Synthesis of Wool-blending Fiber Bundle and New Signs of the Curve

Yonghua Ren[1,2*] **and Jianyong Yu**[1]

[1]*College of Textiles, Donghua University, Shanghai 200051, China*
[2]*College of Textiles, Xi'an University of Engineering Science & Technology, Xi'an 710048, China*
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Abstract: In this paper, a hand-operating method (tiled test method) of the wool-blending sample is made out, and make use of the method, the test of wool-blending bundle in different blending ratio is accomplished. According to the test data, the synthesis method of the stretch curve is worked out and the synthesis software for the typical stretch curve of wool-blending bundle is designed. Through laboratory hand-operating method, the blending fasciculus applying to fiber bundle test can be obtained in a short time. Calculation for sampling is accomplished in the article. We bring up 9 new signs to describe the characteristics of the curve behind peak for the first time: elongation behind peak (*HE*), elongation percentage behind peak (*HEP*), relative elongation rate behind peak (*RHE*), total break work (W_a), break work behind peak (*HW*), break work coefficient behind peak (*HWC*), elongation percentage of half-load behind peak (*HEL*), load percentage of half-elongation behind peak (*HLE*), break efficiency behind peak (*HEC*).

Keywords: Wool-blending bundle, Stretch curve, Blending ratio, Hand-operating method, New signs

Introduction

The bundle strength indexes show its superiority in the prediction and analysis of the wool yarn quality. The time and power consuming of the single fiber test become the factors that restrict the analysis efficiency [1]. The test of the blending fiber bundle properties is a hard nut to resolve at the spinning process. Because after the blending top have already produced in factory, then the test and prediction would not have so much meaning. The important meaning of the prediction consists in that foreknow the yarn quality before production, however, at that time there have no blending top to test. The primary purpose of this paper is: By means of researching the stretch characteristic of wool-blending fiber, develop a method that make use of the different kinds of pure fiber stretch curve to predict the blending curve and index in different blending ratio.

It is necessary to acquire the test sample before the blending bundle strength test. The blending sample can be acquired by the following means [2]: taking the blending top from factory, slivering with the miniature combing equipment. The above two methods are in common use now. The matter of the first method is that the tested fiber bundle (drawing out from the top) and the top are not identical in blending ratio. At the same time, it is difficult to obtain different ratio sample, what need to consume a great deal of material, laborers, resources and time. Slivering in miniature also have its limitation, it require a great deal of material, laborers and purchasing special equipments to acquire different ratio blending top [3].

Whereas the limitation of the above two ways, the handcraft blending system is adopted. The substance of the method consists in weighing pro rata.

*Corresponding author: ryh@mail.dhu.edu.cn

Experimental

Instrument

The instrument is wool fiber bundle strength tester (SIROLAN −TENSOR) made in Australia CSIRO. It consists of tensile tester, computer, application software, air compressor, analytical balance etc. The system can measure tensile properties quickly and accurately, and operate conveniently and safely. The accuracy and the automatic degree is high. TENSOR has high availability to the measurement and analysis of material property and product quality.

Material

In order to making the test result had the catholicity, we chose two kinds of combinatorial sample. One is wool and polyester, the relation of two curves is inclusive, the other is wool and silk, the relation of two curves is cross. The relationship between any two kinds of fiber is included in the following form: inclusive and cross. As Figure 1 shows.

Calculating Process

① Taking a spot of wool fiber, weighing the fiber bundle after combing out the shorts. Putting it into the clamp of TENSOR to cut off, then weighing it. The percentage of middle occupying the whole should be worked out. Repeating the above process to 20 times attain the average, and the symbol of the average is q_w.

② In the same method, working out the percentage of polyester (or other fiber), and the symbol is q_p.

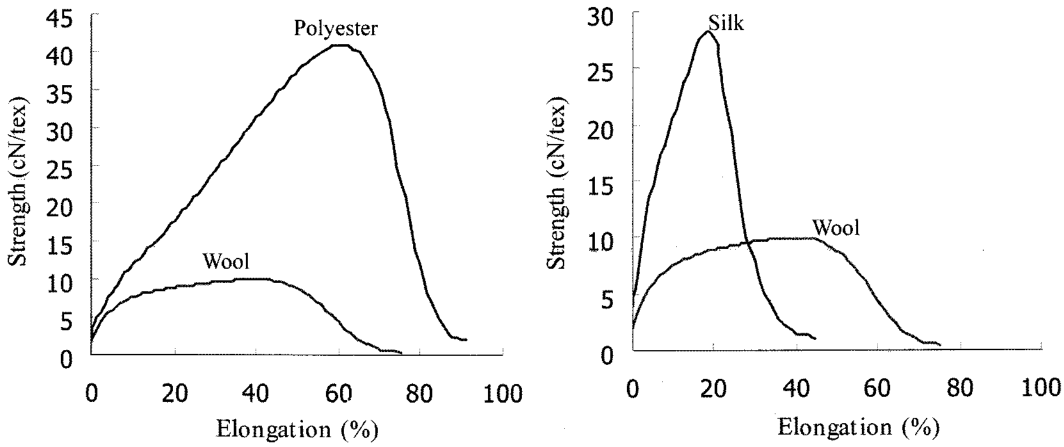

Figure 1. (a) Curves of inclusive relation, (b) curves of cross relation.

$$q_w = g_w/G_w,\ q_p = g_p/G_p,\ h = g_w/g_p$$

$$q = q_w/q_p = g_w/g_p \times G_p/G_w = h \times G_P/G_w \quad (1)$$

$$G_P = G_w \times q/h \quad (2)$$

Note:

g_w : Middle wool fiber weight (mg)
g_p : Middle polyester fiber weight (mg)
G_w: Weight of wool fiber after combing (mg)
G_p: Weight of polyester fiber after combing (mg)
h : Blending ratio
q_w : Percentage of middle occupying the whole of wool
q_p : Percentage of middle occupying the whole of polyester

Referring to equation (2) to reckon, q and h are known, so G_p can be reckoned out.

Defining the Test Method

There are 3 methods to put the fiber, as follows. Composite type, abreast type and tiled type (such as Figure 2(a),(b),(c) show). All the fiber bundles adopted have been combed before put it into the instrument. Composite type is in the following process: put the fiber bundle into the clamp of TENSOR, and comb it again until blending evenly, then pull it. Abreast type is the form putting the fiber into the clamp separately, there is a small gap between two kinds of fiber, then not to comb fiber again but pull it directly. Tiled type is the form putting the two kinds of fiber into the clamp layered. That is to say one kind of the fiber laying on the other, then not to comb fiber again but pull it directly.

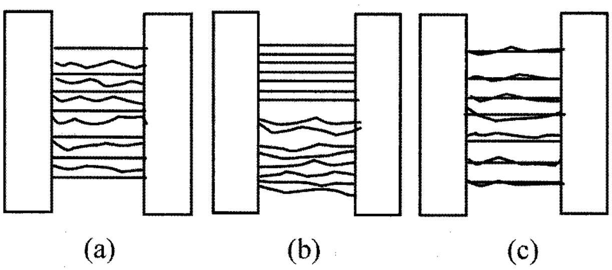

Figure 2. Three methods of fiber putting.

Analyzing and comparing the 3 means, it can be seen in course of the test, in order to blending the fiber evenly, composite type need to comb the fiber again. In course of the combing, there is almost no shorts that chemical fiber would be combed out for its high uniformity, it is ignorable. But for natural fiber such as wool etc., although there have been already a great of shorts combed out in course of the first combing, it cannot avoid to be combed out fiber by second combing. So there may be a little difference between the ratio of the fiber bundle tested and the ratio designed. There is no again combing in the second method; however, in course of the stretch we found that the thickness of two kinds of fiber is different, because the property of the material is different. The thin fiber slide in the stretch process, consequently it will cause to deviation of the result. At the same time, there is also difference in the setting mode between the tested and the factual blending top. The result tested by the third means is credible relatively, and it is also convenient. Therefore, it is adopted to research the tensile property of the blending fiber bundle in laboratory.

Results and Discussion

Blending Curves

Make use of the laboratory hand-operating system, we obtained samples of different blending ratio for two fiber kinds, and the tensile curves. The blending ratios of W/P are as follows: 96/4, 94/6, 92/8, 90/10, 85/15, 75/25, 65/35, 55/45, 45/55, 35/65, 25/75, 15/85, 10/90; the blending ratios of W/S are: 95/5, 90/10, 85/15, 80/20, 70/30, 60/40, 50/50, 40/60, 30/70, 20/80, 10/90. We got out the tensile curve according to test data, as shown in the Figure 3, Figure 4.

It can be seen from above two curve diagrams, the difference

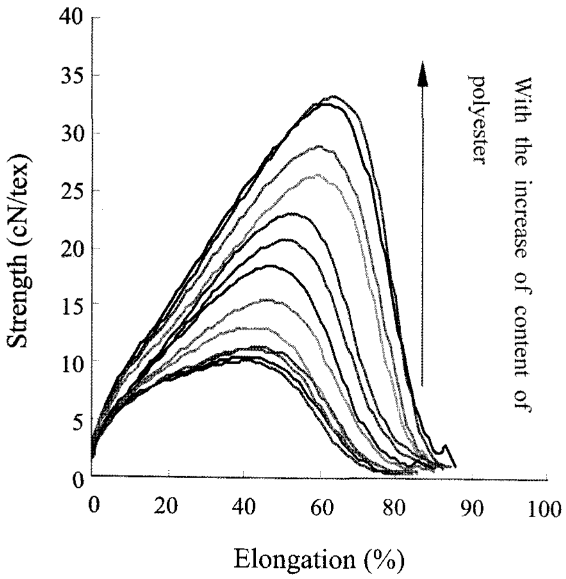

Figure 3. Tensile curve of W/P blending fiber bundle.

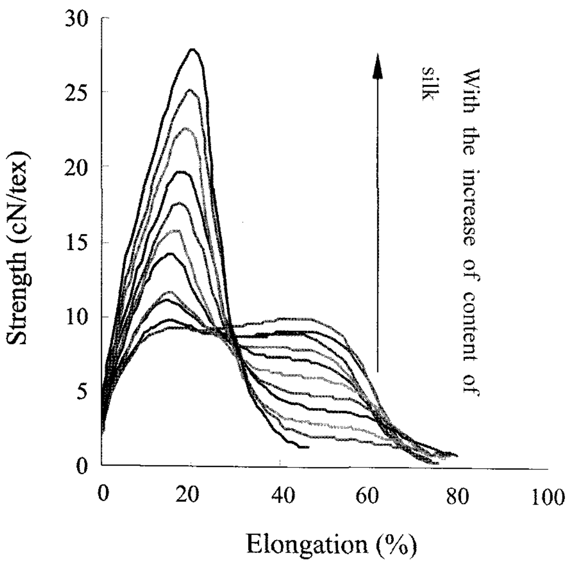

Figure 4. Tensile curve of W/S blending fiber bundle.

between the follow two states is obviously: the curve that used same material at the different blending ratio and the curve that used different material at same blending ratio. The traditional signs mostly aim at the left side of the curve, that can't describe the characteristic of the curves completely [4]. There is seldom description for the right side of the curve, but the characteristic of this part has very big influence on the tensile and break properties of the top and yarn. After discussing carefully, we bring up 9 new signs for the description of the right side of the tensile curve.

The New Signs of the Fiber Bundle Tensile Curve

According to the above two curve diagrams and the experience

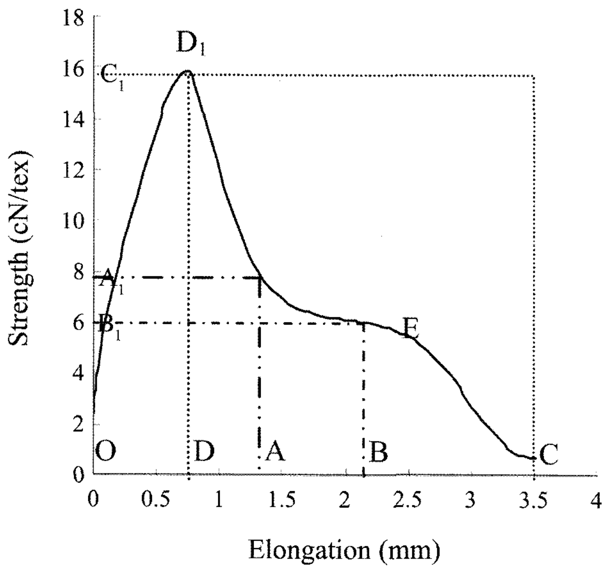

Figure 5. Fiber bundle stretch curve.

acquiring from experiment, we obtained the typical curve such as Figure 5 shows. Then we used it as the analyzing object to analyze the 9 new signs.

Elongation Behind Peak (HE) and Elongation Percentage Behind Peak (HEP)

The elongation behind peak(*HE*) is absolute value of the elongation behind the peak of the curve, there is the elongation percentage behind peak (*HEP*) which is corresponding with the elongation. The numerical value of the new sign means the degree of the break asynchronism, bigger *HE* is, the degree of the break asynchronism will be bigger. Such as the Figure 5 show, the elongation behind peak (*HE*) = OC-OD, the elongation percentage behind peak (*HEP*) = *HE* × 100/*L*(%) (*L*: the gauge of the instrument).

Relative Elongation Rate Behind Peak (RHE)

The percentage that the elongation behind peak (*HE*) divide break elongation is called relative elongation rate behind peak (*RHE*). Bigger *RHE* is, the right part of the curve is longer than the left part. At the same time, it can also elucidate the break tenacity (the deferring ability from beginning to completely break). In the practical application, *RHE* can be connected with the yarn quality. Lower *RHE* is, the break simultaneity will be higher, and so the pertinency of the stretch signs of the breakpoint and the yarn quality will be better. Contrarily, it will be worse. For example the characteristic of the yarn using the lower strength, the higher break elongation, and the lower *HEP* fiber and the characteristic of the yarn using the lower strength, the lower break elongation, and the higher *HEP* fiber may be coincident. Therefore, when the fasciculus has the higher *RHE*, if only consider the peak value, it will cause the mistake for analyzing the connection of fiber with yarn.

Total Break Work (W_a), Break Work Behind Peak (HW), and Break Work Coefficient Behind Peak (HWC)

The work from beginning to completely break is named the total break work (W_a). The work from the peak of the curve to the end is named the break work behind peak (*HW*), the work at the left side of the peak is called break work traditionally. $HWC = HW/W_a$.

Bigger W_a is, resistance to rupture of the fiber is better. Bigger *HW* is, the stretch consistency is worse, and it can also show tensile property of the fiber behind the peak is good (obdurability is good). The *HWC* can also explain the degree of stretch consistency. Bigger HWI is, the consistency is worse, and the tenacity is better.

Elongation Percentage of Half-load Behind Peak (HEL) and Load Percentage of Half-elongation Behind Peak (HLE)

At the right of the stretch curve, the corresponding elongation where the load decline to 1/2 of the peak value is named elongation of half-load behind peak, the percentage that it divide *HE* is elongation percentage of half-load behind peak (*HEL*). Such as Figure 5 show, the elongation at a point is elongation of half-load behind peak. Similarly, at the right part of the curve, the corresponding load where the elongation decline to 1/2 of the peak value is named load of half-elongation behind peak, the percentage that it divide the value peak load is load percentage of half-elongation behind peak (*HLE*). Such as Figure 5 show, the load at B1 point is load of half-elongation behind peak.

The above two signs is used to describe the curve behind the peak, it is necessary to combine one with another. If they are all for 50 %, that testify the curve is straight line descent. If they are all above 50 %, the curve is the convex type. Bigger *HEL* is, the *EC* curve in Figure 5 is more perpendicular, and the postpone terrace is more level. If the *HEL* or *HLE* is under 50 %, the curve is the sunken type. The shape of the curve is different; the tensile property of yarn is different correspondingly.

Break Efficiency Behind Peak (HEC)

The velocity of load declining from the peak to the end of the tensile curve is named the break efficiency behind peak (*HEC*), its value is equal to the elongation behind peak divided by the peak load. Such as Figure 5 show, DD_1/DC is namely for the break efficiency behind peak, its unit is a cN/tex. Bigger *HEC* is, on certain meaning the steep degree at the right part is bigger. But *HEC* can't directly and completely express the characteristic of curve at the right side. Because of the characteristic of the right part curve may appear three kinds of shapes: beginning steep and smooth in the sequel, beginning smooth and steep in the sequel, nearly at even speed, the *HEC* in above three states may be equivalent. Therefore, in order to express the characteristic of the right curve accurately, we should connect *HEL* with *HLE* to describe to curve.

Conclusions

A sampling method of blending fiber bundle, tiled test method is made out, which is effective to research the tensile property of blending fiber bundle in different ratio. Make use of the method, we can obtained the blending fiber bundle before slivering and drawing are finished, and a great deal of time and material are saved.

We bring up 9 new signs to describe the characteristics of the curve behind peak for the first time: elongation behind peak (*HE*), elongation percentage behind peak (*HEP*), relative elongation rate behind peak (*RHE*), total break work (W_a), break work behind peak (*HW*), break work coefficient behind peak (*HWC*), elongation percentage of half-load behind peak (*HEL*), load percentage of half-elongation behind peak (*HLE*), break efficiency behind peak (*HEC*). Make use of these new signs to describe the curve synthetically, we can describe the characteristic of the right side of curve precisely. At the same time, it established a nicer theory and technique foundation for the precise analysis and prediction of the yarn quality and the spinning capability of the fiber.

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