PET single filament 데이터로부터의 번들강도 결정을 위한 통계적 접근

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The Statistical Approach for Determining the Parallel-Bundle Strength from Single-Filament Data of PET

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1. Introduction

Although the tensile strength of textile materials are determined by that of their components, it is well known that the tensile strength of fiber bundles and yarns is not accurately predicted from that of single-fibers by simple averaging methods or mathematical calculations, because of variations in their strength. Therefore, there have been attempts to interpret the bundle strength from that of its elements by the stochastical approach.

In this study, filaments are considered to be composed of elements and a bundle is arrangement of a number of filaments. We discussed a statistical approach for determining the parallel-bundle breakage mechanism from single filament data of PET. We prepared twelve set of composite specimen with different length and number of filaments. The generally accepted series model is examined by using tested result and random breakage model were developed for arrangement of these elements in series and in parallel.

2. Experimental

The filament specimen tested were from 262den/12fiament polyester provided by Kanebo spinning corporation. All specimens tested were drawn from relatively restricted sections of the package, to avoid any large effects which might be encountered through the packages. On the model of the mechanical polyester used in this work, single filaments were separated from filament bundle and prepared to 1-12 filament bundle. Length of 20mm, 30mm, 40mm, 60mm, and 80mm were selected from each of twelve filament bundle, from single filament to 12 filament, respectively. A paper tabs were glued to the ends of the specimen with a polyamide-epoxy resin. The prepared specimen were then tested on Instron(model 4468, UK) by using 100N load cell. The specimens were then mounted in clamps and tested at a cross-head speed of 6omm/min. Data obtained from each test were treated as a set with breaking strength and breaking strain, compared with those sample properties from other sets for filaments of the same polyester yarns.

3. Results and Discussion

The distribution of breaking strength for the single filament of 262den/12filament PET yarn and its gaussian fit are given in Fig. 1(a). It shows that the breaking load of single filaments is normally distributed with the mean and the standard deviation, 0.103kgf and 0.0049, respectively. Fig. 1(b) is a load-extension curve for filament bundles of PET, which is represented that the bundle strengths are linearly increase with the increase of number of filaments, the breaking extension, however, is not shown any significant relation. In the case of this specimen, the parallel bundle had not a significant interaction between adjacent filaments, for example, slack, slippage and friction did not occur when the bundle was loaded. When none of the filaments are broken, the load is supported by all filaments. When one filament breaks and slips free due to no friction between filaments, it is no longer contributing to the strength of the bundle and the surviving filaments stand load one after another, and finally it is abruptly broken. This force from the broken filament can be redistributed in many ways. It can be distributed to all surviving filaments(equal-load sharing). Another possibility is that just the filaments adjacent to the broken filaments support the load from the failed filament(load-load sharing). Here, the adjacent filament support a much greater load than the filaments that are supporting only their own load. After only a few percent of the filaments in the bundle break, the entire bundle fails catastrophically. This tendency was often shown in the bundle with smaller denier and larger number of filaments.

4. Conclusion

This paper discussed the model of random breakage of the bundle arranged in series and parallel. The breaking load-elongation behavior of PET filament yarns has shown that the bundle breakage is determined by load-sharing mechanism of a number of filaments supporting the load in tension. From the statistical model of the bundle strength function for series and parallel-filament arrangement, we could predict the bundle breakage behavior.

5. Reference

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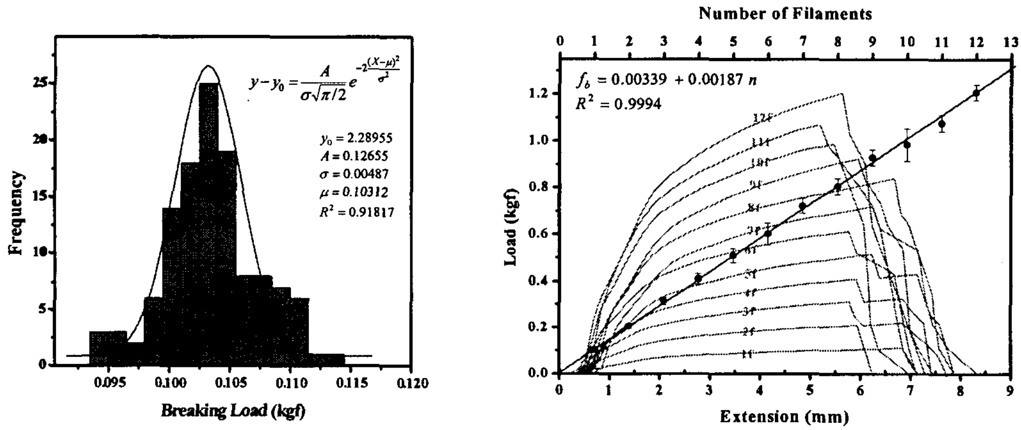

Fig. 1. **(a)** The distribution for the breaking load for single filaments and its gaussian fit.,
(b) The load-extension curve of filament bundle and linear fit for the breaking load of PET filament yarns.