

Contribution of fibre profile and twist factor to flexural rigidity and elastic recovery of polyester fibre yarns

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The flexural rigidity is highest for 2.5 denier trilobal fibres followed by 3 denier trilobal fibres and 3 denier circular fibres. An increase in twist factor results in a significant increase in yarn flexural rigidity. The yarns spun from fine denier fibres show higher elastic recovery. However, for both trilobal and circular fibres, twist factor has no effect on yarn elastic recovery.

Keywords: Circular fibre, Fibre stiffness, Flexural rigidity, Polyester yarn, Trilobal fibre, Twist factor

The contribution of yarn structure to the aesthetic and tactile qualities of apparel fabrics is transmitted through the linear density and surface geometry of the constituent fibres. Some researchers¹⁻⁴ have studied the influence of fibre type, spinning system and twist on yarn flexural rigidity. However, the role of fibre profile is not well understood. The present paper aims at characterizing this effect.

Three polyester fibres of different linear densities and cross-sections were selected for the study. The specifications of these fibres are given in Table 1. Each fibre sample was processed twice on a Platts miniature card. The laps thus obtained were given two passages of drawing on the Platts miniature draw frame. Yarns of 29.5 tex were spun on Platts ring frame using three twist factors.

The yarn flexural rigidity and elastic recovery were tested on a Shirley weighing ring yarn stiffness tester using the ring loop method⁵, the values being calculated from Owen's tables⁶.

Table 1—Specifications of polyester fibres

| Fibre profile | Fibre denier | Fibre length mm | Tenacity g/den | Breaking extension % |
|---------------|--------------|-----------------|----------------|----------------------|
| Trilobal | 2.5 | 51 | 5.15 | 21.6 |
| Trilobal | 3.0 | 51 | 4.45 | 21.5 |
| Circular | 3.0 | 51 | 4.68 | 20.4 |

Table 2 shows that the yarns spun from trilobal fibres exhibit a slightly higher flexural rigidity than the yarns spun from circular fibres owing to the lower bending rigidity of trilobal fibres⁷, the bending rigidity being inversely proportional to the flexural rigidity. The flexural rigidity increases with the decrease in fibre linear density, which is in agreement with the accepted fact that fine denier fibres have lower bending rigidity. As regards the contribution of twist to flexural rigidity, Thierron³ reported that twist level has no significant effect on the flexural rigidity of polyester-cotton ring- and rotor-spun yarns. However, the present study shows that this is not true. An increase in twist factor leads to a significant increase in flexural rigidity owing to an increased inter-fibre cohesion. However, the increase is less for yarns spun from trilobal fibres due to the lesser freedom of fibre movement⁸.

Though the 3 denier trilobal fibres are slightly more extensible than 3 denier circular fibres, the elastic recovery values for the yarns spun therefrom seem to be comparable. For both the trilobal and circular fibres, twist factor has no effect on elastic recovery. This trend can be attributed to the negative contribution of loosely packed trilobal fibres to the elastic recovery due to the permanent displacement relative to the surrounding fibres. On the other hand, the apparent behaviour at high twist factors is expected to be caused by variability of strains⁴. Further, the elastic recovery is low for yarns spun from coarse fibres and it increases with the decrease in fibre linear density, owing to the low stiffness of fine denier fibres.

Table 2—Effect of twist factor on flexural rigidity and elastic recovery of polyester yarns^a

| Fibre profile | Fibre denier | Tex twist factor | Flexural rigidity g.cm ² × 10 ⁻³ | Elastic recovery % |
|---------------|--------------|------------------|--|--------------------|
| Trilobal | 2.5 | 28.71 | 6.84 | 63.25 |
| | | 33.49 | 7.15 | 67.57 |
| | | 38.28 | 7.53 | 72.27 |
| Trilobal | 3.0 | 28.71 | 6.05 | 56.75 |
| | | 33.49 | 6.32 | 63.22 |
| | | 38.28 | 6.45 | 65.60 |
| Circular | 3.0 | 28.71 | 5.38 | 54.75 |
| | | 33.49 | 5.89 | 62.61 |
| | | 38.28 | 6.30 | 66.24 |

^a Yarn linear density, 29.5 tex.

The yarns spun from trilobal polyester fibres have slightly more flexural rigidity and elastic recovery, which further increase with the decrease in fibre linear density. An increase in twist factor leads to a slight increase in flexural rigidity and elastic recovery.

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