Influence of Fibre Denier and Fabric Sett on Fabric Characteristics

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The influence of fibre denier and fabric sett on the tensile strength, breaking extension, flexural rigidity and flex abrasion of fabrics has been studied. The use of finer-denier fibre in the preparation of yarn and the use of the latter in the weft direction in fabric production resulted in a stronger, more extensible, more flexible and abrasion-resistant fabric. Higher sett fabrics were stronger and possessed better abrasion resistance, but were less extensible and less flexible.

The characteristics of a fabric depend mainly on yarn and fabric construction and if the yarn count and yarn and fabric construction are the same, the fabric characteristics become dependent upon fibre type and fibre denier. When technology has advanced to a stage that it is possible to produce regenerated and synthetic fibres with any denier, it becomes important to study the effect of fibre denier on the fabric characteristics so that any one looking towards the end use of a fabric may ask for fibre of that denier which would be able to produce a fabric with the desirable performance characteristics.

The aim of the present investigation was to ascertain the influence of fibre denier on the tensile strength, abrasion resistance, breaking extension and flexural rigidity of fabrics by keeping the final count of weft, the quality of warp and weave the same.

Several workers1-7 have studied the effect of fibre dimensions on various fabric characteristics using different fibres, alone or in blends, but little information is available in the literature on the use of cotton warp and viscose weft, which has become an acceptable way of producing cheap and economical fabrics.

Materials and Methods

Warp—Using J-34 cotton, single 24s count yarn was spun on a ring frame and then it was doubled on a doubling frame to obtain 2/24s count yarn, which was used as warp. Single yarn was Z-twisted and had 24.5 turns/in., while the 2-fold yarn was S-twisted and had 18.2 turns/in.

Weft—Three yarn samples, each of 7s nominal count, were prepared from three viscose fibres of three different deniers, viz. 4, 8 and 12, on a miniature plant using 4.8 TM and giving Z twist. The specifications and characteristics of the fibres used are given in Table 1.

Preparation of fabric samples—Six plain woven fabric samples were prepared using three weft yarns and two nominal fabric constructions, viz. 36 x 24 and 36 x 32.

All the fabric samples were produced on the same loom under identical conditions. They were wet-relaxed in an open trough containing 0.5% Lissapol-D solution at 40°C for 30 min, rinsed twice and dried in relaxed state by spreading on the clean floor.

Before testing, all the fibre, yarn and fabric samples were conditioned in standard atmosphere (65 ± 2% RH and 27 ± 2°C) for 12, 24 and 48 hr respectively.

All the viscose fibres were tested for breaking strength and breaking extension on an Instron tensile tester. The tenacity of each fibre was calculated by dividing the breaking strength of the fibre by its denier.

The count of the yarn samples was measured on a Knowle’s balance and the breaking strength and breaking extension were measured on the Instron tensile tester. The tenacity of each yarn was calculated as for fibre.

The number of threads/in. in warp and weft directions was determined in the usual way by counting with the help of a standard 1 in. pick glass. The warp and weft crimps of the fabrics were determined on a Eureka crimp tester (Shirley type). The value of total crimp was obtained by adding the square roots of warp and weft crimps. The fabric weight was determined by using threads/in., crimp and count of warp and weft. The warp and weft direction tensile strengths and breaking extensions of the fabric samples were measured on the Instron tensile tester. The ravelled stripes (20 x 5 cm) of different fabric samples were prepared using the standard procedure.

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The bending length in warp and weft directions of each fabric sample was determined using the Shirley stiffness tester. The flexural rigidity in warp and weft directions of each fabric sample was calculated using the following relationship:

$$\text{Flexural rigidity} = W L^3$$

where $W$ is the weight of the fabric in mg/cm$^2$ and $L$, the bending length in cm.

The flex abrasion in warp and weft directions of each fabric sample was measured on a Stoll abrasion tester.

## Results and Discussion

### Fibre Characteristics

The values of breaking strength, tenacity and breaking extension for 4, 8 and 12 denier fibres are given in Table 1. It is observed that the coarser the denier the stronger the fibre. The values of tenacity and extensibility are little affected by the fibre denier, as their values for 4, 8 and 12 denier fibres show insignificant differences. This may be due to the fact that these fibres were supplied by the same fibre manufacturer. However, coarser denier fibre, being thicker, obviously results in a higher strength.

### Yarn Characteristics

The values of breaking strength, tenacity and breaking extension for experimental yarns are given in Table 2. It is observed that when the same twist multiplier is used in the preparation of yarns, the yarn produced from coarser denier fibre is weaker, less flexible and exhibits lower tenacity. The reason for this may be that a yarn of the same count but prepared from coarser fibres has a lesser number of fibres in its cross-section, which increase the slipping tendency of fibres in conjunction with reduced frictional force. This increased slippage tendency results in a weaker, less extensible and lower tenacity yarn. According to Gregson and New, the strength and extensibility of a yarn are functions of (a) fibre properties, (b) fibre distribution, and (c) twist.

### Fabric Characteristics

The physical and mechanical characteristics of fabric samples are given in Tables 3 and 4 respectively.

*Threads/in.—Data on threads/in. (Table 3) show that fibre denier has no or little influence on thread density.

*Crimp—The values of warp, weft and total crimps (Table 3) show that the use of coarser denier fibre in the preparation of yarn and the use of the latter in any of the directions cause reduction in warp, weft and total crimps and that the trend is independent of fabric sett.

*Fabric weight—The values of fabric weight for various fabric samples (Table 3) show that the fabrics having 8 denier fibre weft yarn are heaviest in both groups of fabrics. The probable reasons for this are that 8D yarn is the coarsest among 4D, 8D and 12D yarns (Table 2) and the total threads, i.e. warp threads/in. plus weft threads/in., are highest for 8D24 and 8D32 fabrics among their own groups.

*Tensile strength—The values of warp and weft tensile strengths (Table 4) show that the use of coarser denier fibre in the preparation of yarn and the use of the latter in the weft direction cause reduction in both warp and weft tensile strengths and that the trend is
independent of fabric sett. The reason for such a trend may be that when the twist multiplier and nominal count are the same, a yarn produced from a coarser denier fibre is weaker because of more slippage between the fibres (Table 2) and a fabric prepared from a weaker yarn will be weaker, as the fabric tensile strength is highly dependent on the tensile strength of yarn\(^6,9\). The reason for increase in strength due to increase in pick density is the increase in cohesion between warp and weft yarns and so also within the fibres as a result of increased interlacement per unit area\(^8,9\).

**Breaking extension**—The values of warp and weft breaking extensions (Table 4) show that the use of coarser denier fibre in the preparation of yarn and the use of the latter in the weft direction cause reduction in both warp and weft breaking extensions and that the trend is independent of fabric sett. The reason for such a trend may be that a yarn prepared from coarser denier fibre is less extensible (Table 2) when the twist multiplier and nominal count are nearly the same, and a fabric prepared from a less extensible yarn would also be less extensible. This happens when all 4D, 8D and 12D fibres have nearly the same level of breaking extension (Table 1). The reason for decrease in breaking extension due to increase in pick density may be that as the number of interlacements in the fabric increases, there is a resultant increase in the building effect of the yarns, thereby increasing the tension. As a result, the component threads in the fabric remain in tension, which reduces their extensibility.

**Flexural rigidity**—The values of warp and weft flexural rigidities (Table 4) show that the use of coarser denier fibre in the preparation of yarn and the use of the latter in the weft direction cause increase in warpway flexural rigidity, except in 8D fabrics of both groups, and in weft-way flexural rigidity. The reason for increase in fabric stiffness is that a coarser denier fibre is itself stiffer and, therefore, produces a stiffer yarn, which, in turn, produces a stiffer fabric\(^3,4\). The reason for higher stiffness in a higher pick density fabric may be that increase in pick density results in increase in yarn-to-yarn and fibre-to-fibre frictions, which restrict the free movement of fabric while bending, thereby causing increased stiffness.

**Flex abrasion**—The values of warp and weft flex abrasion (Table 4) show that the use of coarser denier fibre in the preparation of yarn and the use of the latter in the weft direction cause reduction in both warp and weft flex abrasion and that the trend is independent of fabric sett. The probable reason for lower abrasion resistance in coarser denier fibre fabric vis-a-vis finer denier fibre fabric is the presence of a lesser number of fibres bearing rubbing during cycles in the former. Further, coarser fibres get damaged earlier during abrasion than finer fibres, when the resultant count of yarn and twist multiplier are the same, because of lesser free movement. The reason for lower abrasion resistance in lower pick density fabric may be the presence of lesser yarns sharing abrasion, thereby causing earlier damage\(^5\).

**Conclusion**

The use of finer denier fibre in the preparation of yarn and of the latter in the weft direction in fabric production result in a stronger, more extensible, more flexible and better abrasion-resistant fabric. Higher sett fabrics are stronger and possess better abrasion resistance, but are less extensible and flexible.

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