Consideration of Initial Strain Energy & Yarn Contraction to Yarn Torque(I)
- Theoretical Concepts -

金 承 辰 · *S. K. Tandon · *G. A. Carnaby

부산대학교 공과대학 섬유공학과
*뉴질랜드 섬유연구소(WRONZ)

Abstract

Theoretical analysis to the textile mechanics were analysed by using force analysis (stress analysis) and energy method. The first applications of energy method to the fibre assembly mechanics were done by Olofsson in fabric mechanics in 1964 and by Hearle in nonwoven in 1967 respectively. Many researches of theoretical analysis to the yarn torque were performed by Platt, Postle et al by using force analysis method. But, there was no research relating to yarn torque using energy method.

Theoretical analysis, first of all, must be analysed by simulating practical phenomena precisely. Then, practical phenomena of single yarn torsion on freshly spun yarns in spinning process or on torque experiment of twisted set yarns are as follows. Yarns are applied some tensile load, and some extension which is accompanied by 1) some untwisting 2) radial contraction of outer fibres 3) extension of fibres lying in the jamming regions. If the yarns are further twisted, two phenomena will be occurred, i.e. 1) twisting with constant length 2) twisting with longitudinal length change. Detail phenomena in the 1st case are accompanied by the radial contraction of outer fibres, and further extension of fibres in the jamming regions. Occurred phenomena in 2nd case will be beyond limiting packing density in jamming regions, i.e., no fibres develop tensile strains and central fibres try to relieve their tensile strains by reducing their helix pitch. These phenomena are called 'yarn contraction'. The yarn contraction is converted to yarn torsional buckling under some conditions.

The phenomena explained previously in practical yarn twisting is the first problem, consideration of yarn contraction, which must be included in the theory as theoretical yarn torque is analysed. Next problem is consideration of initial strain energy which must be included in the theory.

Total stored energy in freshly spun yarns or unset yarn is the sum of decrimping energy, tensile energy, helix energy (fibre bending energy + fibre torsion energy) and packing energy. Unset yarns usually have the residual torque which is initiated by initial strain energy in the yarn due to deficiency of degree of setting. The initial strain energy in the yarns prerequisitely must be considered in the theoretical yarn torque appricable to the freshly spun yarns (or unset yarns).