Consideration of Initial Strain Energy & Yarn Contraction to Yarn Torque(Ⅱ)
- Theory & Experimental -

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Abstract

Theoretical yarn torques under such concepts as explained in previous paper(Ⅰ) were analysed into two models using energy method, i.e. Case Ⅰ and Case Ⅱ. These theoretical results were compared and discussed with experimental ones.
The basic hypothesis is 'shortest-path' which the equilibrium position of the fibre paths in the yarn is predictable. This 'shortest-path hypothesis' was applied to calculate yarn torque, which is due to fibre extension, fibre bending and fibre torsion with application of the principle of virtual work. These theoretical treatments assume yarns to be non-interactive fibre structure wherein each fibre is a discrete component of the structure and the aggregate response of the assembly is obtained simply by adding the separate contribution of the individual fibres. The estimated theoretical yarn torque which calculated by experimental fibre mechanical properties was simulated with changing various yarn specific volumes in jamming regions ($\upsilon_{jam.}$). Effects of $\upsilon_{jam.}$ to fibre strain (ε_{fj}), initial fibre curvature (κ_{jo}), initial fibre torsion (τ_{jo}), and initial helix angle (α_j) to the fibre radial position in the yarns were analysed and discussed. Theoretical results in Case Ⅰ and Case Ⅱ were compared and discussed with those of experimental ones, respectively. Especially, torsional buckling limiting force, F_y^* is deduced by buckling initiating torque, T_b, yarn bending rigidity, $(EI)_y$, and yarn length, L. Specimen, wool carpet yarns (300tex) with various twist ranges (90 ~ 240t.p.m.), for these analysis were prepared. Experimental yarns torque test were established by KES-YN1 torque

tester. Various mechanical and physical properties of constituent fibres and yarns such as fibre tensile modulus, shear modulus, fibre tensile strain, fibre diameter, yarn diameter, and yarn strain were also experimented for calculating estimated theoretical yarn torque.