

Yarn Torque Behaviors by Using Energy Method

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Abstract

As twisted yarn is subjected to tensile deformation, fibre tensile strain energy term completely dominates the other strain energy terms arising from the bending and torsional deformations of fibres. In this research, 'shortest-path' hypothesis which the equilibrium position of the fibre paths in the yarn is predictable 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 structures 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 yarn torque which calculated by experimental fibre mechanical properties was simulated with changing various yarn packing factors, and yarn strains. Specimen (carpet yarn) which has 300tex (linear density), with various twist ranges (90 ~ 240t.p.m.) were prepared. Yarn torque and its changes with varying yarn strain, ϵ_y from 0.001 to 0.06 are negligible in the case of yarn torque due to fibre bending and torsion. Yarn

torques of fixed $\epsilon_y = 0.001$ and with varying packing factor, Φ were analysed. There were no contributions of yarn torque due to fibre tension in case of $\Phi = 0.1$ and 0.29 , on the other hand, in the cases of $\Phi = 0.4$ and 0.7 , the contributions of yarn torque due to fibre tension were dominant. The contributions of yarn torque due to fibre bending and torsion and its changes with varying packing factor were negligible comparing to yarn torque due to fibre extension. The same results were shown in other yarn strains ($\epsilon_y = 0.01, 0.03$ and 0.06). The only one difference is that yarn torque due to fibre extension is dominant from $\Phi = 0.29$, but from $\Phi = 0.4$ in the case of $\epsilon_y = 0.001$. Then experimental yarn torque is more larger than that of estimated yarn torque.