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Engineering Ultra-Low Elongation Braided Constructs Using UHMWPE Fibres

Executive Summary

A medical device OEM required the development of a braided UHMWPE construction engineered to minimise elongation while maintaining the flexibility and handling characteristics expected of high-performance medical textiles.

Although UHMWPE fibres exhibit inherently low elongation, braided structures introduce additional deformation through yarn movement and structural reorientation under load. The objective was therefore to optimise braid architecture to reduce structural elongation without compromising manufacturability or handling performance.

By controlling braid geometry, yarn configuration, and processing parameters, the programme established a repeatable approach to engineering ultra-low elongation braided constructs for load-bearing medical applications.

The Challenge

Achieving ultra-low elongation in braided textiles requires balancing mechanical stability with the flexibility needed for handling and device integration.

Key engineering challenges included:

- Minimising structural elongation within the braid
- Controlling fibre movement associated with UHMWPE's low-friction surface
- Maintaining flexibility without compromising structural stability
- Achieving consistent braid geometry throughout production
- Supporting repeatable manufacturing performance

The programme therefore focused on controlling structural behaviour through braid architecture rather than relying solely on material properties.

Engineering Objectives

The programme aimed to:

- Develop an ultra-low elongation UHMWPE braided construction
- Optimise braid geometry to reduce structural extension
- Improve load stability while maintaining flexibility
- Establish repeatable manufacturing conditions
- Create a scalable platform for high-performance medical braid development

Development Approach

Braid Architecture Optimisation

Development focused on reducing structural elongation by optimising braid geometry and yarn interaction.

Key design variables included:

- Braid angle optimisation
- Selection of 110 dtex and 165 dtex UHMWPE yarns
- Packing density and surface profile optimisation
- Coreless braid architecture
- Controlled friction between yarn elements

Rather than modifying the base material, performance was engineered through careful management of textile architecture and fibre interaction.

Validation & Performance Assessment

Assessment focused on evaluating the structural characteristics associated with ultra-low elongation braid performance.

Evaluation included:

- Load-extension behaviour
- Dimensional stability under tensile loading
- Structural integrity
- Braid uniformity
- Knot security and slippage assessment

The development established an engineering framework for evaluating structural elongation while demonstrating consistent braid formation suitable for further application-specific validation.

Process Control & Repeatability

Manufacturing repeatability was achieved through control of key braid parameters, including:

- Consistent yarn specification
- Fixed carrier configuration
- Controlled PPI and braid density
- Stable yarn tension
- Standardised haul-off conditions
- Batch traceability and production records

These controls reduced manufacturing variation and supported consistent braid geometry across production.

Engineering Outcome

The programme demonstrated that structural elongation in UHMWPE braided constructs can be significantly influenced through braid architecture rather than fibre selection alone.

Key engineering outcomes included:

- Reduced structural elongation through geometric optimisation
- Improved load stability under tension
- Stable coreless braid architecture
- Repeatable manufacturing performance
- A scalable engineering platform for low-elongation braided medical textiles

The project reinforced that predictable mechanical behaviour depends on the interaction between material properties, braid architecture, and manufacturing process.

Application Relevance

Orthopaedics & Sports Medicine

High-strength sutures, ligament reconstruction, tendon repair, and soft tissue fixation systems requiring minimal elongation under load.

Surgical Sutures & Closure Systems

Braided non-absorbable sutures when dimensional stability and load retention are critical.

Cardiovascular

Braided reinforcement structures and implantable textile components requiring controlled mechanical behaviour.

Minimally Invasive & Robotic Surgery

Load-bearing braided elements used within catheter-delivered devices and minimally invasive delivery systems.

Advanced Implants & Tissue Technologies

Engineered textile implants requiring predictable long-term mechanical stability.

Key Takeaways

- Structural elongation is governed by braid architecture as well as material properties.
- Geometry optimisation provides an effective route to improving load stability.
- Coreless braid designs require careful management of yarn interaction.
- Repeatable process control is essential for predictable mechanical performance.
- Engineering material, structure, and process together enables scalable development of high-performance braided medical textiles.

"Ultra-low elongation is achieved through engineering the braid structure, not simply selecting high-performance fibre."

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2755 Canyon Boulevard, 1st Floor
Boulder, CO 80302