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December 2000

Development of Scalable Mono-Material Polyester Braided Structures

Executive Summary

A development programme was undertaken to evaluate how braid architecture influences structural performance and manufacturability within a fully polyester braided construction.

Two braid formats were developed:
- USP 3/0
- USP 2/0

Each configuration utilised a mono-material design comprising a braided polyester sleeve and polyester monofilament core. The objective was to assess structural stability, repeatability, and scalability across size formats while maintaining consistent braid geometry and handling characteristics.

Rather than introducing additional materials or reinforcement layers, the programme focused on using braid construction itself as the primary engineering variable to control performance.

The project demonstrated that geometry-driven braid design can support scalable manufacturing while maintaining structural consistency within simplified mono-material architectures.

The Challenge

Developing stable braid constructions across multiple size formats required maintaining consistent structural behaviour while preserving process repeatability.

Because no secondary reinforcement materials were introduced, performance tuning relied entirely on braid architecture and core-sleeve interaction.

Key engineering challenges included:

- Maintaining structural stability using a fully polyester construction
- Preserving consistent core centring across braid sizes
- Balancing flexibility and axial stiffness through geometry control
- Preventing braid distortion during scaling
- Maintaining surface uniformity and braid consistency

The development required precise management of braid geometry to ensure scaling did not compromise structural integrity.

Engineering Objectives

The programme focused on:

- Developing stable USP 3/0 and USP 2/0 polyester braid formats
- Demonstrating geometry-driven performance control
- Maintaining structural consistency across scale changes
- Optimising core-sleeve interaction
- Improving manufacturing repeatability
- Establishing scalable process conditions

Development Approach

A fully polyester core-sleeve construction was developed to isolate the influence of braid architecture on performance.

The design combined a 100% polyester braided sleeve for structural containment and flexibility with a 100% polyester monofilament core providing axial support and controlled stiffness.

Performance was optimised through adjustment of carrier distribution, pick density, braid angle, and core-sleeve interaction, enabling flexibility, stability, and dimensional consistency to be tuned through geometry rather than material variation.

Validation & Structural Assessment

Validation focused on confirming structural consistency and manufacturability across both braid formats.

Assessment activities included:

- Visual inspection of braid coverage
- Core alignment verification
- Structural integrity evaluation during handling
- Comparative assessment between USP 3/0 and USP 2/0 constructions

Testing confirmed repeatable braid formation and stable core integration across both configurations.

Process Control & Repeatability

Process Control & Repeatability

Consistent output was achieved through controlled management of:

- Carrier tension balance
- Core feeding alignment
- Pick density consistency
- Braid angle control
- Standardised machine setup conditions

Additional stabilisation steps were implemented following production to preserve braid geometry.

These controls supported repeatable manufacturing performance and reduced structural variability across production runs.

Engineering Outcome

The project demonstrated that braid geometry can be used as the primary engineering mechanism for controlling performance within simplified mono-material textile systems.

Key engineering outcomes included:

- Stable braid formation across multiple size formats
- Controlled core-sleeve integration
- Improved understanding of geometry-driven behaviour
- Repeatable manufacturing performance
- Reduced complexity through mono-material construction

The programme reinforced the value of braid engineering as a scalable design approach for high-performance textile structures.

Application Relevance

Surgical Sutures & Closure Systems

Relevant to braided non-absorbable structures where flexibility, dimensional stability, and predictable handling are critical.

Cardiovascular Device Components

Applicable to flexible reinforcement structures requiring controlled geometry and stable mechanical behaviour.

Orthopaedics & Sports Medicine

Suitable for fixation and reinforcement applications requiring controlled load sharing and long-term dimensional stability.

Minimally Invasive Device Systems

Relevant to flexible braided elements requiring repeatable performance within constrained delivery environments.

Advanced Implants & Tissue Technologies

Applicable to engineered textile structures where geometry is used to tailor mechanical response.

Key Takeaways

- Mechanical performance was controlled through braid geometry rather than material variation.
- Mono-material construction reduced complexity and improved process stability.
- Core-sleeve interaction played a key role in structural consistency.
- Controlled process conditions supported repeatable manufacturing.
- Scalable braid architectures can maintain performance across multiple size formats.

"The project demonstrated that structural performance can be tuned through braid geometry alone, enabling scalable performance without increasing material complexity."

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