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Braid Construction Optimisation for High-Performance Polyester Tape

Executive Summary

A development programme was initiated to engineer a braided polyester tape capable of meeting tightly controlled dimensional, mechanical, and handling requirements within an uncoated construction format

The customer specification required:
- Tape width between 1.5-1.75mm
- Straight pull strength of 30 kgf
- Knot pull strength of 15 kgf
- Clean cut edges with no tapering or fraying
- Consistent handling characteristics

Rather than relying on coatings or secondary treatments to achieve edge stability, the project focused on using braid architecture as the primary engineering mechanism for controlling strength, flexibility, dimensional consistency, and fray resistance.

Through optimisation of braid density, yarn interaction, carrier configuration, and process control, the programme established a scalable polyester tape construction capable of delivering repeatable mechanical performance and controlled edge integrity.

The Challenge

The development required balancing multiple competing requirements within a tightly constrained braid architecture.

Increasing braid density improved tensile strength and structural compactness but also influenced flexibility, knot performance, and handling characteristics. At the same time, the construction needed to maintain stable cut edges without coating systems traditionally used to control fraying.

Key engineering challenges included:

- Achieving high tensile strength while preserving flexibility
- Delivering reliable knot performance within a compact braid structure
- Maintaining edge stability without coatings
- Preventing tapering and fraying at cut edges
- Controlling dimensional consistency within narrow tolerances
- Preserving clinically usable handling characteristics

Because each structural adjustment affected multiple performance variables simultaneously, the development required careful optimisation of braid construction and process conditions.

Engineering Objectives

The programme focused on:

- Achieving defined straight pull and knot pull targets
- Maintaining dimensional consistency within the 1.5-1.75mm width range
- Eliminating reliance on coating systems
- Optimising braid density and yarn interaction
- Preserving flexibility and handling characteristics
- Establishing scalable and repeatable manufacturing conditions

Development Approach

Construction Optimisation

Braid architecture was used as the primary mechanism for controlling both mechanical and physical performance characteristics.

Key engineering strategies included:

- Increasing picks per inch (PPI) to improve braid compactness
- Enhancing yarn-to-yarn interlock to improve edge stability
- Balancing structural integrity with clinical handling requirements
- Controlling fray resistance through structure rather than coating

This approach leveraged braid geometry and fibre interaction to directly influence:

- Tensile performance
- Abrasion resistance
- Knot behaviour
- Edge integrity
- Handling characteristics

Manufacturing Configuration

The tape was manufactured using a modified 16-carrier braiding system:

- Material: 100% polyester (PET, 455 dtex, Type 712)
- Carrier configuration: 11 active carriers with single strand loading
- Core structure: Fully braided construction (no warp core)
- Gearing: 50 x 40
- Haul-off setting: 50 mm

Following braiding, the tape edges were heat sealed using a hot knife process to maintain clean cut geometry and prevent loose filament ends.

The resulting process configuration supported compatibility with scalable medical textile manufacturing environments.

Validation & Performance Assessment

Validation was performed using established textile and medical device evaluation methods to confirm structural consistency and mechanical performance.

Assessment activities included:

- Straight pull tensile testing
- Knot pull strength evaluation
- Visual and microscopic inspection of edge integrity
- Fraying assessment
- Dimensional verification within the specified width range

Testing confirmed that braid construction alone could achieve the required balance of strength, handling performance, and edge stability without reliance on coating systems.

Process Control & Repeatability

Repeatability manufacturing performance was achieved through controlled management of:

- Picks per inch (PPI)
- Carrier loading consistency
- Yarn distribution uniformity
- Machine gearing and haul-off settings
- Heat sealing conditions

Standardisation of these parameters improved batch-to-batch consistency and supported scalable manufacturing capability suitable for regulated medical textile production.

Engineering Outcome

The project demonstrated that braid architecture can be used to achieve clinically relevant performance targets without secondary coating systems.

Key engineering outcomes included:

- Achievement of defined tensile and knot pull requirements
- Stable edge integrity within an uncoated construction
- Controlled dimensional performance
- Repeatable manufacturing capability
- Balanced flexibility and handling characteristics
- Scalable production readiness

The programme reinforced the role of textile engineering as a primary driver of mechanical and handling performance within advanced braided structures.

Application Relevance

Cardiovascular

Suitable for soft tissue support and fixation applications requiring dimensional stability and repeatability performance.

Orthopaedics & Sports Medicine

Applicable to ligament and tendon repair systems where polyester tapes are used for reinforcement and load-bearing fixation.

Soft Tissue Repair & Closure Systems

Relevant to non-absorbable braided structures where knot performance and retained tensile strength are critical.

Minimally Invasive & Robotic Surgery

The controlled edge profile supports smooth instrument passage while minimising snagging and fray-related disruption.

Advanced Implants & Tissue Technologies

Suitable for textile-based implant structures requiring long-term dimensional stability and mechanical consistency.

Key Takeaways

- Mechanical and edge performance can be achieved through braid construction rather than coatings.
- Braid density and yarn interaction directly influence strength, handling, and fray resistance.
- Controlled process parameters improve repeatability and manufacturing scalability.
- Structural optimisation supports predictable clinical handling characteristics.
- Textile engineering enables performance through architecture rather than secondary treatments.

"The project demonstrated that strength, handling, and edge integrity could be engineered directly into the braid structure without reliance on coating systems."

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