March 2012

Optimising Braid Compliance and Diameter Through PPI Control in Polyester Constructions

Executive Summary

A development programme was undertaken to evaluate how picks per inch (PPI) influences mechanical compliance and dimensional control within braided polyester constructions.

Using an 8-carrier braid architecture and a fixed polyester material platform, the study isolated PPI as the primary process variable to determine how braid architecture alone can deliver predictable performance outcomes.

The resulting work established a validated operating window that enables targeted tuning of braid compliance and dimensional performance while maintaining process repeatability and manufacturing simplicity.

The Challenge

In braided textile systems, increasing braid density typically improves structural compactness but can negatively affect flexibility, handling characteristics, and dimensional behaviour.

The baseline construction exhibited excessive consolidation, creating a mismatch between the inherent flexibility of the polyester yarn and the delivered braid performance.

Observed issues included:

- Excessive structural stiffness
- Reduced suppleness and handling performance
- Increased inter-yarn friction
- Over-compaction of braid geometry
- Diameter deviation from target specifications

The engineering challenge was to improve compliance and recover target dimensional behaviour without changing material inputs, carrier configuration, or machine architecture.

Engineering Objectives

The programme focused on:

Reducing braid stiffness

Improving flexibility and handling characteristics

Aligning braid diameter with specification targets

Maintaining structural integrity

Establishing a repeatable process window

Demonstrating architecture-driven optimisation without material change

Development Approach

Controlled PPI Optimisation

An **8-carrier PET HT FDY polyester braid (95 d)** was used to evaluate the effect of **PPI** on braid compliance and diameter.

PPI was reduced from **48** to **36–43**, while yarn input, carrier tension, machine configuration, and take-up conditions remained fixed. This isolated braid density as the primary variable influencing mechanical behaviour.

Structural Optimization

The working hypothesis proposed that reducing PPI would:

- Reduce braid density
- Lower inter-yarn friction
- Increase structural compliance
- Reduce compaction
- Shift finished diameter toward target values

The objective was not to identify a single ideal setting but to establish a controllable operating window.

Validation & Performance Assessment

Progressive reduction in PPI demonstrated clear and repeatable behaviour trends.

Optimised Operating Window (36-43 PPI)

Observed outcomes included:

Increased braid suppleness

Reduced structural constraint

Lower inter-yarn friction

More open braid architecture

Diameter movement toward target specification

Below Operating Window (<36 PPI)

Observed:

- Reduced structural cohesion
- Early indications of braid instability
- Increased risk of yarn separation

Above Operating Window (>43 PPI)

Observed:

- Persistent stiffness
- Excessive compaction
- Reduced handling performance

These findings demonstrated that performance optimisation occurs within a controlled process range rather than at a fixed point.

Process Control & Repeatability

Defining an operating window enabled repeatable control of:

- Flexibility
- Diameter
- Structural behaviour
- Handling characteristics

Process consistency was supported through:

- Controlled PPI management
- Stable yarn tension
- Standardised machine conditions
- Monitoring of braid geometry

The programme demonstrated that PPI can function as a primary manufacturing control mechanism for performance tuning.

Engineering Outcome

The project confirmed that PPI is not simply a machine setting but a functional design parameter capable of controlling braid performance.

Key engineering outcomes included:

- Improved compliance without material substitution
- Controlled dimensional tuning
- Reduced development complexity
- Defined process operating limits
- Repeatable manufacturing performance

The work established a scalable optimisation strategy capable of improving braid behaviour without introducing new materials or process redesign.

Application Relevance

Surgical Sutures & Closure Systems

Supports the development of braided sutures requiring controlled flexibility, knot performance, and dimensional consistency.

Orthopaedics & Sports Medicine

Relevant for braided fixation constructs where handling and load distribution must be balanced.

Cardiovascular Devices

Applicable to flexible textile structures requiring controlled compliance and dimensional precision.

Minimally Invasive & Robotic Surgery

Lower stiffness may support smoother delivery and improved device control in constrained procedural environments.

Advanced Implants & Tissue Technologies

Demonstrates how textile architecture can be used to tune mechanical behaviour without changing biomaterial systems.

Key Takeaways

- PPI directly influences compliance, diameter, and braid behaviour.
- Performance optimisation can be achieved without changing materials.
- Operating windows provide greater manufacturing robustness than fixed settings.
- Controlled braid density improves flexibility while maintaining cohesion.
- Process variables can function as design tools in medical textile engineering.

"By treating PPI as a design variable rather than a fixed process setting, braid performance was tuned without changing materials or manufacturing platforms."

Contact Corza Medical today

2755 Canyon Boulevard, 1st Floor
Boulder, CO 80302