Effect of Sizing Optimization on Yarn Breakages in Poly/Modal Weaving

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Abstract

This study explores Poly/modal blended yarns are extensively used in modern textile applications due to their excellent combination of softness, strength, moisture management, and wearer comfort. However, during high-speed weaving, these yarns often experience frequent warp breakages caused by abrasion, yarn hairiness, electrostatic charge accumulation, and insufficient yarn cohesion. These breakages result in frequent loom stoppages, reduced weaving efficiency, and inferior fabric quality.

This research investigates the impact of sizing optimization on reducing yarn breakages in 40s poly/modal (70% modal / 30% polyester) warp yarns. The study evaluates pre-sizing and post-sizing yarn characteristics including tensile strength, elongation, evenness, hairiness, abrasion resistance, and count strength product (CSP). A carefully optimized sizing formulation consisting of binders, lubricants, antistatic agents, and film-forming components was applied using a Karl Mayer sizing machine. Weaving trials were conducted to assess warp breakage rate, loom efficiency, and fabric defects. The results demonstrate that optimized sizing significantly enhances yarn performance, minimizes breakages, and improves overall weaving efficiency and fabric quality.

Keywords: Yarn, Fabric, Weaving, Poly modal blend, Sizing, Strength and Elongation

1. Introduction

The textile industry continuously seeks to improve weaving efficiency while maintaining superior fabric quality. Poly/modal blended yarns have gained widespread acceptance in apparel and home textiles due to the strength of polyester fibers and the comfort properties of modal fibers. Modal, a regenerated cellulose fiber, provides high moisture absorption and softness, whereas polyester contributes dimensional stability and tensile strength.

Despite these advantages, poly/modal yarns present significant challenges during weaving, particularly in the warp direction. Modal fibers have lower abrasion resistance and higher hairiness, while polyester fibers tend to generate electrostatic charges during high-speed operations. These factors collectively increase yarn-to-yarn and yarn-to-machine friction, leading to frequent yarn breakages.

Sizing is a critical warp preparation process designed to protect yarns from mechanical stresses during weaving. Proper sizing improves yarn strength, smoothness, cohesion, and resistance to abrasion. However, improper sizing formulation or application can result in stiff yarns, brittle size films, or inadequate protection. Therefore, optimizing the sizing process is essential for achieving stable weaving performance in poly/modal yarns.

1.1 Problem Identification and Industrial Relevance

In industrial weaving conditions, frequent yarn breakages lead to:

- Increased loom downtime
- Reduced production efficiency (observed 60–65%)
- Increased labour involvement
- Higher defect rates in finished fabric
- Increased manufacturing cost

Poly/modal yarns are especially sensitive to weaving stresses due to fiber heterogeneity and surface irregularities. Hence, this study addresses a critical industrial problem by improving warp yarn performance through sizing optimization.

2.Objectives of the Study

The main objectives of this research are:

1. To investigate the primary causes of yarn breakages in poly/modal warp yarns during weaving
2. To evaluate the influence of sizing on yarn tensile strength, elongation, and CSP
3. To analyze the reduction of yarn hairiness and abrasion damage after sizing
4. To study the effect of optimized sizing formulation on loom efficiency and stoppage frequency
5. To enhance fabric quality by minimizing weaving defects
6. To establish an optimized sizing methodology suitable for poly/modal blended yarns

3. Literature Review

Previous studies have emphasized the importance of warp sizing in improving weaving efficiency. Researchers have shown that sizing reduces yarn hairiness, enhances surface smoothness, and improves resistance to repeated abrasion during shedding and beating-up actions. The use of synthetic binders such as PVA and PC binders improves film strength, while softeners increase flexibility and reduce brittleness of the size layer.

Studies on regenerated cellulose fibers highlight their susceptibility to abrasion and moisture-related degradation. Modal fibers, although stronger than viscose, still require adequate surface protection during weaving. Literature also reports that antistatic finishes are essential when polyester blends are woven at high speeds, as static charge accumulation can cause yarn repulsion, snarling, and breakage.

However, limited research has been conducted on sizing optimization specifically for poly/modal blends, making this study highly relevant to current industrial needs.

4. Materials Used

4.1 Yarn Details

- Yarn count: 40s
- Blend ratio: 70% Modal / 30% Polyester
- Application: Warp yarn for weaving

4.2 Sizing Chemicals and Their Functions

Sizing Chemical		Function
Size Fix 150	-	Improves adhesion of size film to yarn
Size Edge	-	Protects warp edges and prevents selvedge fraying
PC Binder	-	Enhances film strength and cohesion
Sico 12	-	Acts as softener and lubricant
ASF	-	Reduces electrostatic charge
Water	-	Medium for size dispersion

5. Methodology

5.1 Pre-Sizing Yarn Testing

Before sizing, the following yarn properties were tested:

- Tensile strength and elongation using UT-4 and UT-5 (Tensojet)

- CSP using CSP testing machine
- Evenness and hairiness
- Abrasion resistance

These tests provided baseline data for evaluating the effectiveness of the sizing process.

5.2 Warping Process

Warping was carried out using a Benninger warping machine operating at speeds between 700 and 1100 rpm. Proper tension control was maintained to avoid yarn damage prior to sizing.

5.3 Sizing Process

Sizing was performed using a Karl Mayer sizing machine. The yarn was passed through the following stages:

1. Immersion in optimized sizing bath
2. Squeezing to control size pick-up
3. Drying under controlled temperature conditions

Uniform size add-on was ensured to maintain yarn flexibility and strength.

5.4 Weaving Trials

Weaving trials were conducted to evaluate:

- Warp breakage rate
- Loom stoppages
- Weaving efficiency
- Fabric defects

Performance of sized yarns was compared with unsized yarns.

5.5 Post-Sizing Yarn Testing

After sizing, yarns were tested again for:

- Tensile strength and elongation
- Abrasion resistance
- Hairiness reduction
- Size add-on percentage

6. Results and Discussion

The results indicate a noticeable improvement in yarn performance after sizing. Tensile strength and elongation showed measurable increases, indicating improved yarn cohesion. Hairiness reduction resulted in smoother yarn surfaces, reducing friction during weaving. Abrasion resistance improved significantly, enabling the yarn to withstand repeated mechanical stresses.

Weaving efficiency improved beyond the initial 60–65%, and warp breakages were substantially reduced. The optimized sizing formulation effectively balanced film strength and flexibility, preventing yarn brittleness and breakage.

7. Conclusion

This study confirms that sizing optimization plays a vital role in improving the weaving performance of poly/modal yarns. The application of an optimized sizing formulation significantly enhances yarn strength, reduces hairiness, improves abrasion resistance, and minimizes warp breakages. As a result, loom efficiency and fabric quality are improved. The findings provide valuable insights for textile industries seeking to improve productivity while maintaining fabric performance.

8.References

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