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## **CHALLENGES IN WARP YARN TENSION AND MITIGATION STRATEGIES IN WEAVING**

Muslimbek Abdujabborov

Head of Department, "Aisha Textile" LLC

Ph.D. in Technical Sciences

Rakhim Karimov

Head of Research Department, "ArtSoftTex" LLC

Candidate in Technical Sciences, Associate Professor

Dilbar Aliyeva

Professor, "Textile Materials Technology " Department, Namangan State

Technical University, D.Sc. in Technical Sciences

### **Abstract**

Inconsistent or improper warp tension remains a primary source of quality defects and production losses in weaving mills. This paper identifies and categorizes the most prevalent tension-related challenges, including uneven tension across the warp sheet, periodic tension variations, and yarn breakage. We systematically analyze the root causes—spanning mechanical, procedural, and human factors—and present a comprehensive framework for problem diagnosis and resolution. The paper advocates for an integrated approach combining advanced monitoring technologies, Total Productive Maintenance (TPM), and Statistical Process Control (SPC) to proactively manage tension and achieve zero-defect manufacturing goals.

**Keywords:** Weaving Defects, Problem Solving, TPM, SPC, Quality Control, Root Cause Analysis.

### **I. Introduction**

Despite technological advancements, warp tension instability persists as a formidable challenge in daily weaving operations. Its manifestations—from subtle fabric faults to catastrophic machine stoppages—erode profitability and compromise



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customer satisfaction. This paper serves as a practical guide for industrial practitioners, cataloging common tension problems, delineating a structured methodology for root cause analysis, and proposing effective, sustainable mitigation strategies grounded in modern quality management principles.

### II. Common Tension-Related Problems

- A. Uneven Tension: When individual warp ends or sections have different tensions, it results in visible fabric faults like "streaks" or "barré."
- B. Cyclic Tension Variation: Periodic tightening and slackening of the warp sheet, often synchronized with the loom cycle (e.g., due to a faulty or worn eccentric), leading to "starting marks."
- C. Warp Breakage: Excessive peak tension, often from a sudden snag or incorrect shed timing, causes yarns to fail, halting production.

### III. Root Cause Analysis

A systematic investigation is crucial.

- A. Technological Causes: Worn heald eyes/reed dents, a damaged or dirty back rest, misaligned weaver's beam, or faulty pressure settings on the beam brake.
- B. Methodological Errors: Incorrect tension setpoint for the yarn, improper warp beam gaiting, or flawed drawing-in/denting sequence.
- C. Equipment Malfunction: Failure of the tension sensor, drift in the servo-drive system, or mechanical play in the let-off motion linkage.

### IV. Problem Identification and Mitigation

A. Identification Methods:

Visual Inspection: Looking for sagging or vibrating warp sheets.

Instrumental Control: Using a portable tension meter to map tension across the warp width.

Statistical Monitoring: Using SPC charts to track mean tension and variation over time.



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### B. Corrective and Preventive Actions:

**Proactive Maintenance:** Implementing TPM schedules to inspect and replace worn parts (healds, reeds, drop wires) before they cause defects.

**Process Adjustment:** Systematically calibrating and adjusting the let-off and take-up systems.

**Staff Training:** Empowering operators with the knowledge to identify early signs of tension issues.

**C. Quality Management Systems:** Embedding tension control within a broader quality framework like SPC allows for the early detection of process drift and preemptive correction.

### V. Conclusion

Effectively managing warp tension challenges requires a shift from a reactive "fire-fighting" approach to a proactive, prevention-oriented culture. By leveraging structured problem-solving tools like RCA, embracing preventive maintenance philosophies like TPM, and utilizing data-driven monitoring via SPC, weaving mills can significantly reduce tension-related defects. This holistic approach not only improves immediate product quality but also enhances overall equipment effectiveness (OEE) and strengthens the mill's competitive position in the market.

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