On-line Measurement of Fabric Mechanical Properties for Process Control

Investigators: Sabit Adanur, Yasser Gowayed, Howard Thomas (Auburn Univ.)
Tushar Ghosh (NC State Univ.)

Graduate Students: Jing Qi, Mohamed Esad (Auburn University)
Wenshang Huang (NC State Univ.)

Goal:

To develop principles of on-line measurement of fabric properties to improve product quality.

Abstract:

Dynamic filling yarn tensions were measured on a Tsudakoma ZA203 air-jet loom using different count cotton yarns. Fabric samples were woven under different filling tension levels and then tested for fabric weight, thickness, permeability, dimensional stability, abrasion resistance, drapeability, tear strength, breaking load, elongation, stiffness and fabric wrinkle recovery. An attempt was made to correlate the filling tension and the fabric properties.

After weaving, each fabric was divided into two sections. One section was washed and dried, and the other was left in the greige state in order to compare the results. All fabric testing was according to ASTM and AATCC standards. Before testing, the samples were conditioned under standard conditions (25°C, 65% RH).

Introduction:

Mechanical properties of fabrics are altered either by design or as a side effect in most textile processes. The ability to monitor or control fabric properties in real time is contingent upon the availability of a system to measure these properties on-line and in real time. This is becoming increasingly important with higher levels of automation. The envisaged system will contribute toward manufacturing quality fabrics at lower costs, by minimizing the need for expensive routine laboratory tests of fabrics.

Results:

1. Fabric Weight
Samples were weighed using ASTM D-3776 specifications. The fabric weight increased with an increase in filling tension which resulted in the formation of heavier fabric. When the average filling tension increased further, the filling yarn was stretched which resulted in decrease of the fabric weight (Figure 1).

2. Fabric Thickness

The samples were measured according to ASTM D1777 - 96 specifications. With the increase of filling tension, the yarn becomes straightened and stretched. The higher the average filling tension, the thinner the fabric (Figure 2).

3. Fabric Air Permeability

With increasing filling tension, fabric becomes thinner and the openings between yarns get larger. The air permeability is generally increased (Figure 3).
4. Fabric Dimensional Stability

Filling tension introduced during weaving is one of the reasons, which makes a fabric shrink after washing. When the stressed fabric is agitated in water, the internal tension may be relieved. The structural readjustment takes place. The dimensional changes of fabric were tested using AATCC test method 135-1992. Filling-way shrinkage was measured after first and fifth washing and drying cycle (Figure 4).

5. Abrasion Resistance

The abrasion resistance of fabric is the ability to withstand rubbing (frictional force) applied to its surface. Fabrics with high abrasion resistance retain their physical integrity. Fabrics with low abrasion resistance become thin and/or develop holes. They were tested using AATCC test method 93-1989 (accelerator method).
6. Fabric Drapeability

Fabric drapeability is related to fabric weight, stiffness, and shear resistance. The greater the fabric weight, the better the drapeability. The greater the fabric stiffness, the worse the drapeability.

7. Fabric Tear Strength

Fabric tear strength is a reflection of the individual strength of yarns. The fabric filling way tear strength was tested according to ASTM D 1424-83 specification (Figure 7).
8. Fabric Breaking (Tensile) Strength

Fabric samples were tested in wet and dry condition as specified in ASTM D 5035-90. The filling way breaking load verses average filling tension is shown in Figure 8.

9. Fabric Elongation

Fabric filling way elongation was measured according to ASTM D 5035-90 (Figure 9).
10. Fabric Stiffness

Fabric stiffness was tested using ASTM D1388-64 specification. The filling way fabric stiffness verses average filling tension is shown in Figure 10.

![Fabric Stiffness Graph](image)

**FIGURE 10. Fabric stiffness vs average filling tension**

11. Fabric Wrinkle Recovery

The fabric wrinkle recovery was tested according to AATCC test method 66-1990 specification. The fabric filling way wrinkle recovery verses average filling tension is shown in Figure 11.

![Fabric Wrinkle Recovery Graph](image)

**FIGURE 11. Fabric wrinkle recovery vs average filling tension**

**Summary and Conclusions:**

In this study, a yarn tension measurement system was developed. Filling and warp tensions were measured on line on an airjet weaving machine. A 3/1 left-handed twill fabric was woven. Yarn and fabric properties were tested according to ASTM and AATCC standard test methods. On the basis of the test results, the following conclusions can be made:

- the higher the yarn count, the higher the average filling tension per cycle
- the higher the yarn twist multiplier, the lower the filling tension
- hairiness increases filling tension
- higher friction coefficient of yarn results in higher tension
- increasing filling tension increases fabric air permeability
- lower filling tension results in higher abrasion resistance
- the higher the filling tension, the lower the tear and tensile strength
- higher filling tension results in higher filling direction flexural rigidity.