Tissue Properties and Manufacturing

Forming and TAD Fabrics

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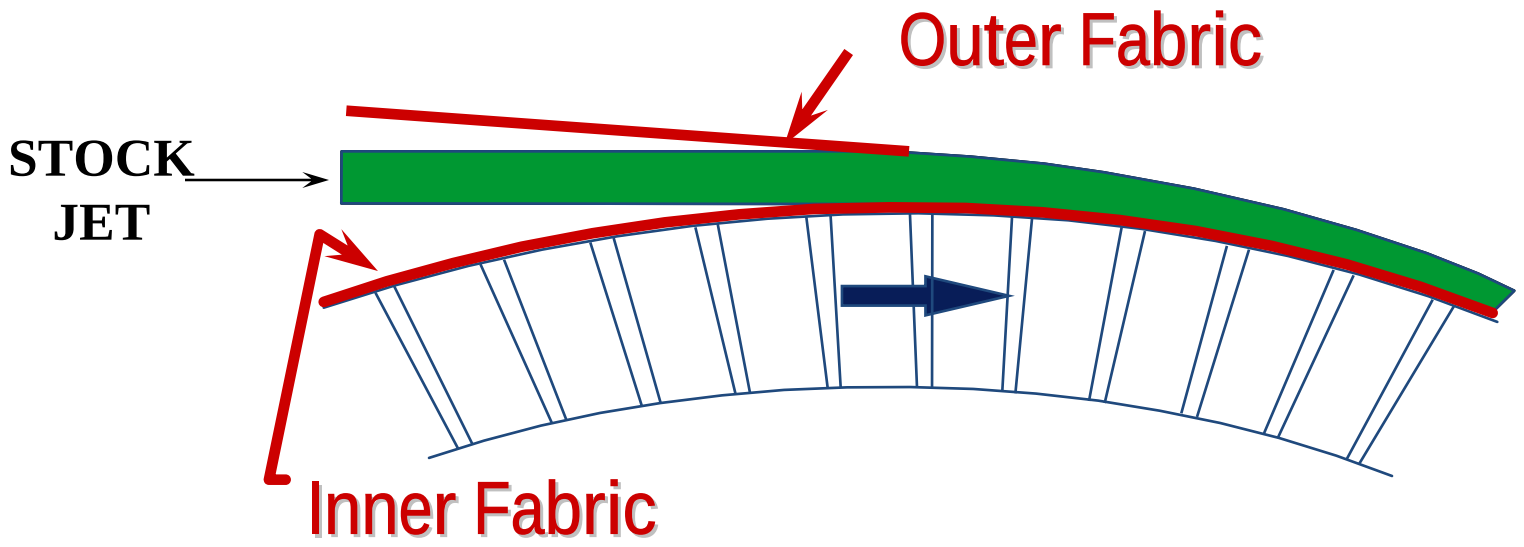
Forming Fabrics

Role of Forming Fabrics on Tissue Production

"THE FORMING FABRICS ARE THE MAJOR INTERFACE BETWEEN THE STOCK JET AND THE MECHANICAL ELEMENTS FORCING DRAINAGE TO OCCUR"



FORMING FABRICS THEREFORE

Impact Paper Machine and Fiber Efficiency as well as Final Sheet Quality

Role of Forming Fabrics on Tissue Production

Stock Drainage – Take fiber from head box consistency of 0.05 – 0.50% and deliver sheet to pick-up / transfer at 8-25%

Provide Fiber Support – Build uniform sheet, desired sheet properties, and first pass retention

Efficient Machine Operation – Drainage rate, fiber and water carry back, cleanability, and drive load are all impacted by the forming fabric design

Productivity– Machine speed, breaks, sheet transfer, holes all impact the machine production efficiency

Energy Use – Higher solids to pick-up and uniform drying

Role of Forming Fabrics on Tissue Production

Sheet Properties – The forming fabric will impact

Directly

- sheet formation,
- sheet profiles (CD and MD)
- Tensile strength
- Fiber orientation
- mechanical retention

Indirectly - uniformity of the sheet delivered to the crepe blade

- Sheet softness
- Bulk
- Stretch
- Absorbency

Forming / TAD Fabric Terminology

- **Monofilament Strand** – Forming / TAD fabrics are woven on a loom from extruded plastic yarns. Modified polyester is the most common material but other materials, such as nylon, are also used
- **Strand Size** – 0.10 mm to 0.45mm most common in Tissue Fabrics
- **Warp** – The machine direction (MD) strands.
- **Weft (shute)** – The cross machine direction (CD) strands.
- **Mesh** – The number of MD strands per unit area (inches or cm).
- **Count (knock)** – The number of CD strands per unit area (inches or cm).
- **Weave** – The design of the pattern in the fabric
- **Shed Pattern**– The repeat pattern in the design

Forming / TAD Fabric Terminology

- **Drainage Area %** - The percent open area on the sheet side of the fabric. Can also calculate mid-plane and machine side DA for multi-layer fabrics
- **Frames Count** – The number of holes per unit area in the sheet side of the fabric
- **Support Points** – The number of knuckles per unit area on the sheet side of the fabric
- **FSI** – Fiber support index. Calculation used to indicate how well the fibers are supported on the sheet side of the fabric. Can compare similar designs only. Has limitations on complex double and triple layer fabrics
- **Maximum Frame Length** – Distance between CD strands on widest MD drainage hole

Forming / TAD Fabric Terminology

- **Caliper**- The thickness of the fabric
- **Void Volume** – The amount of space in a volume of fabric that is not occupied by solid material. Can affect water carry of a fabric. Void volume is used to calculate the require flooded nip water required to flush a fabric.
- **Elastic Modulus** – The resistance to stretch in the MD direction. Important for fabric stability
- **Air Permeability** – Measure of air flow through a fabric at a standard area and pressure drop. Normally listed as cfm. Not an indicator of drainage rate on fabrics of different designs.
- **Drainage Index** – Design as a tool for determining relative drainage rate of a fabric design. Effective for single layers but not double or triple layers as the mid-plane and bottom layers are not involved in the calculation.

Fabric Design Selection

Considerations

- Weave
- Material
- Mesh/Count
- Strand Diameter

Parameters

- % Drainage Area
- Air Permeability
- Maximum Frame Length
- Frames count & Shape
- Elastic Modulus
- Caliper – Void Volume
- Fiber Support Index
- Cleanability

Machine Design Considerations

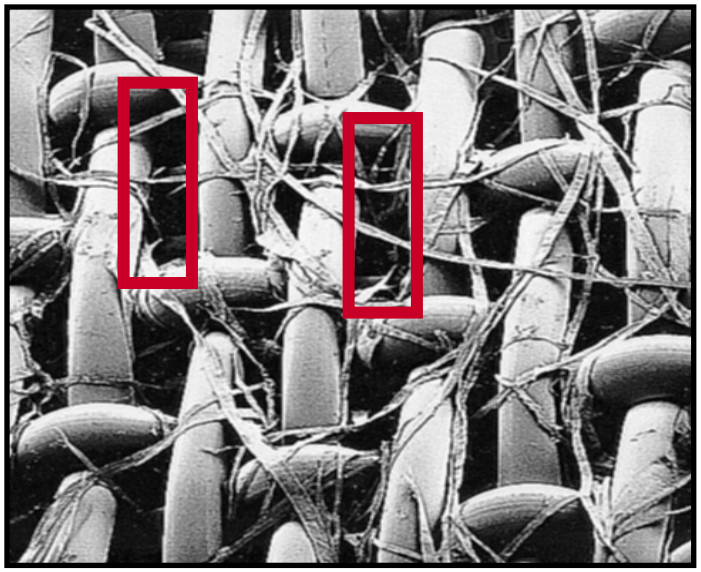
PAPER

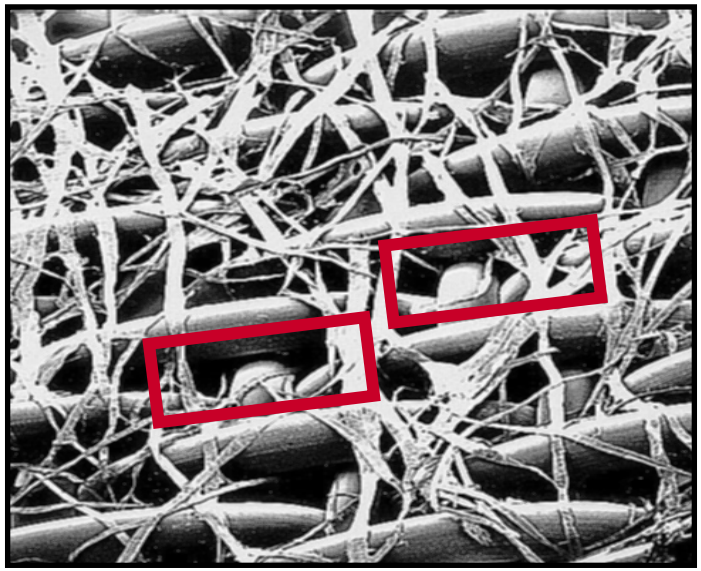
- Grade of Paper
- Type of Furnish
- Weight Range of Product
- Wire Mark Considerations

PAPER MACHINE

- Type and Manufacturer
- Size (width and length)
- Speed Range
- Type of Pickup
- Head box Flow Rate
- Operating Tension
- Take-Up Length
- Fabric Run History
- Shower Set Up

Fiber Support - The Critical Difference





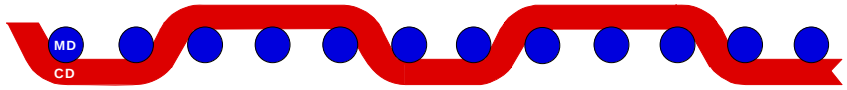
- **Same fiber, same fabric, same method…different results.**

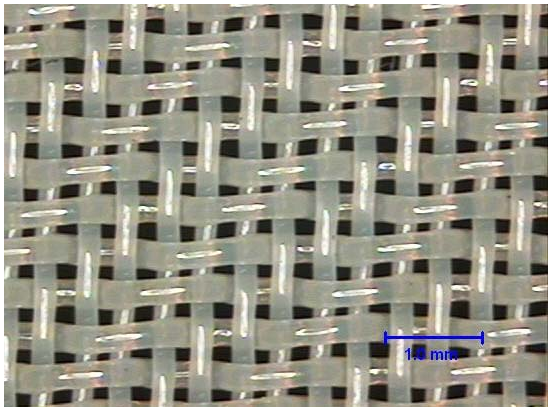
Forming Fabric Design Construction

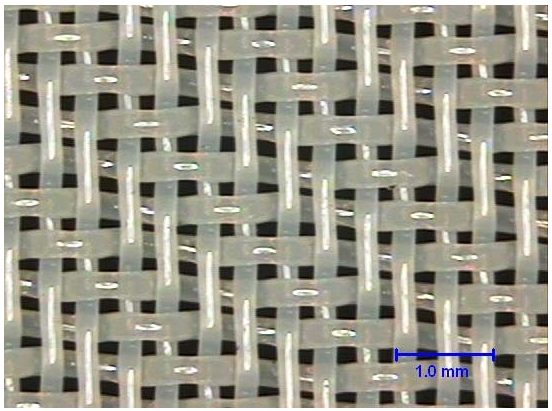
- **Single Layer** - have One MD Yarn and One CMD Yarn.
- **Double Layer** - have One MD Yarn and Two CMD Yarns.
- **2.5 Layer** - have One MD Yarn and Three CMD Yarns.
- **Triple Layer** - have Two MD Yarns and Two or Three CMD Yarns Depending on the Method Used to Bind the Two Layers of the Structure.

Single Layer Profiles

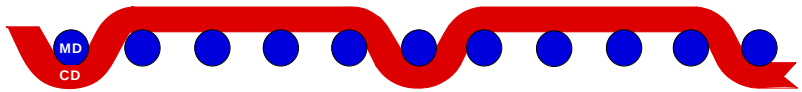
5 Shed, 2,3

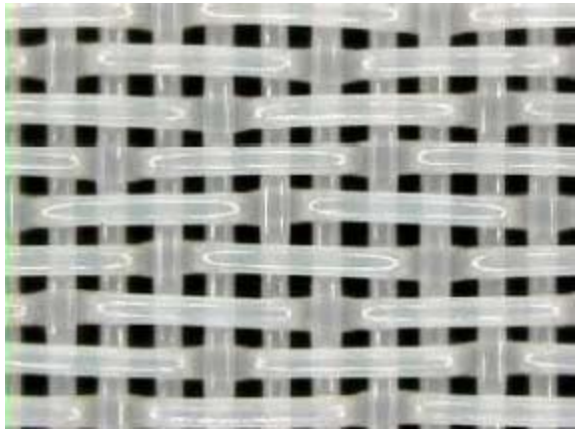


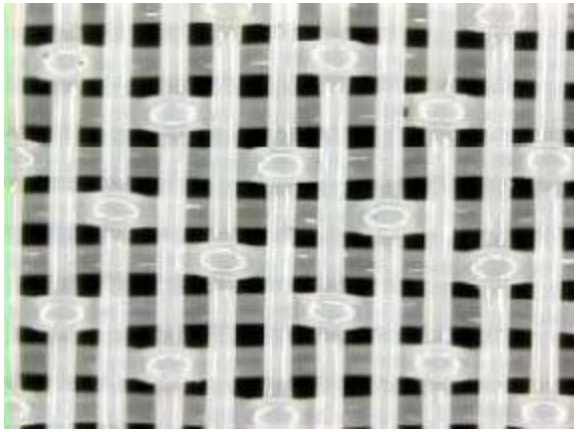




5 Shed, 1,4

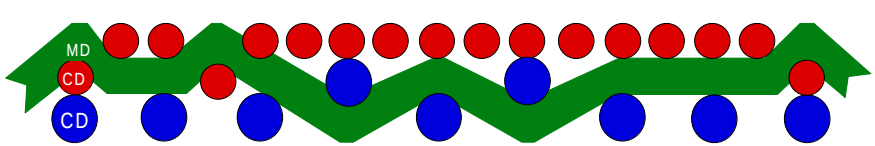


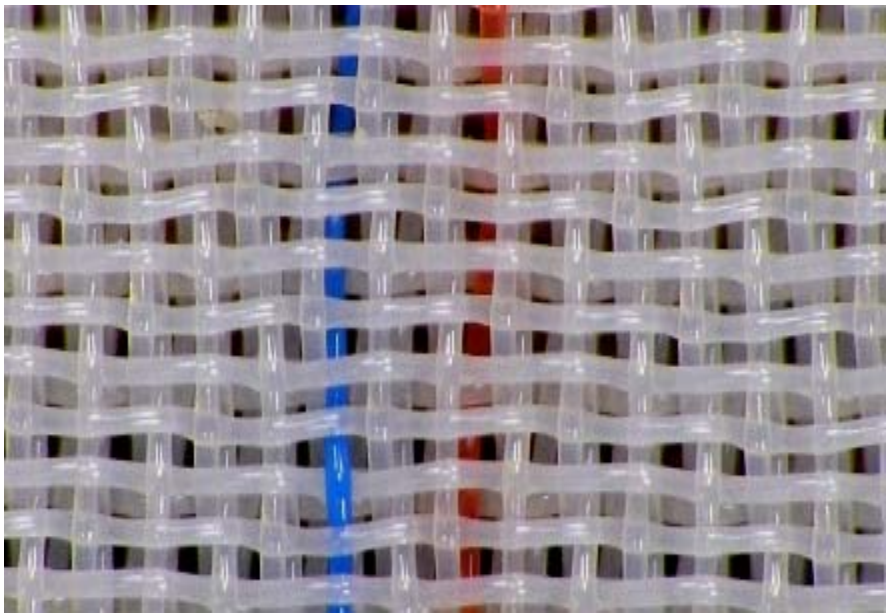


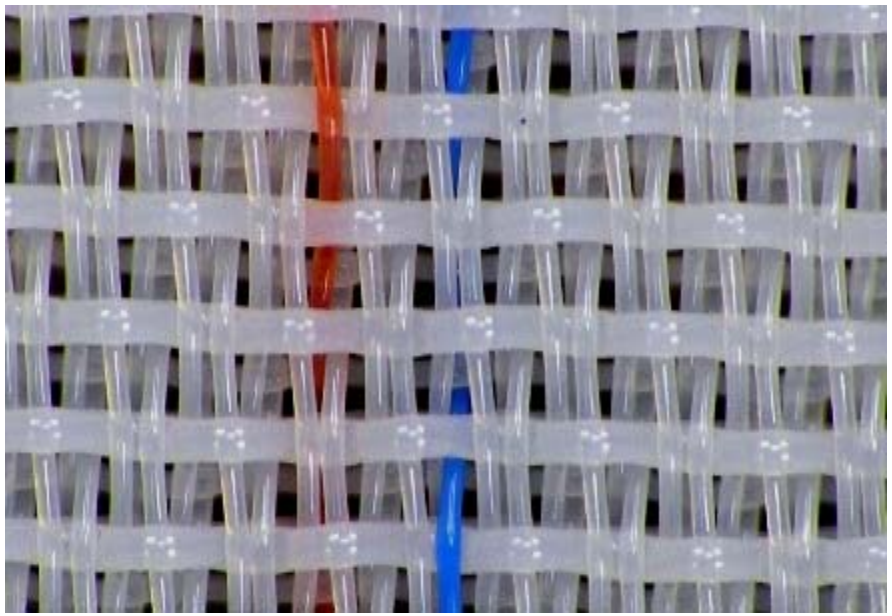


Double Layer Profiles

8 Shed

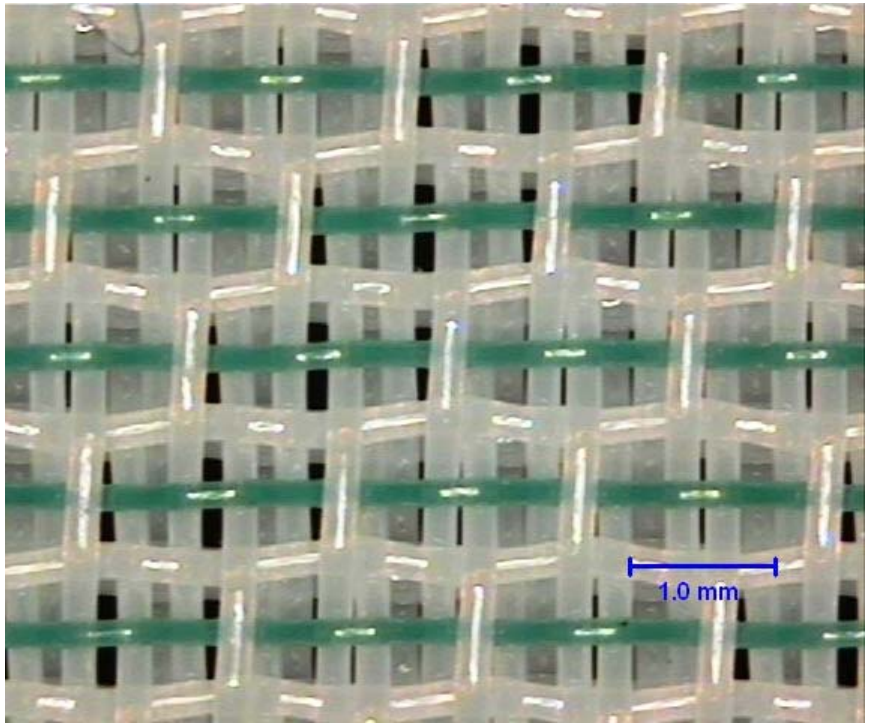


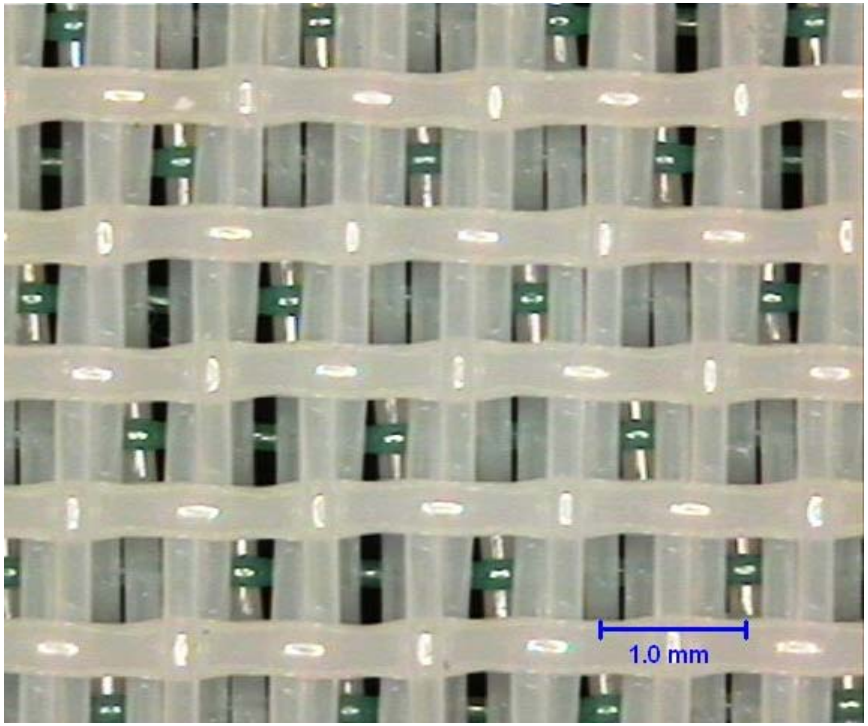




2.5 Layer Profiles

7 Shed

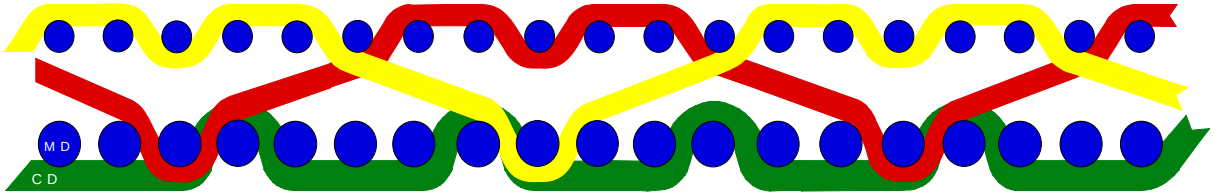




Triple Layer Profiles

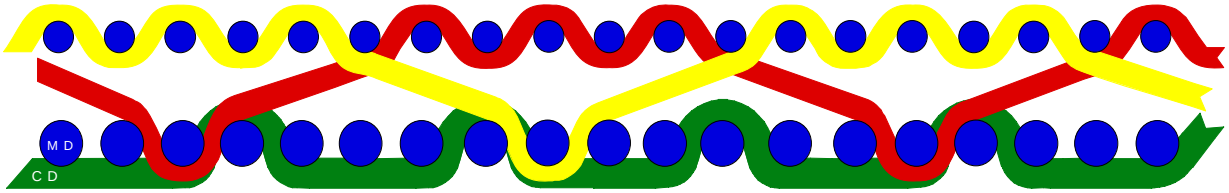
3 Shed Top

4 Shed Bottom



Plain Weave-Top

4 Shed Bottom



Forming Designs and Applications

Single Layer

(OT 20-35 PLI)

Advantage

- Lowest Cost
- Easy to Clean

Disadvantage

- Low Fiber Support
- Low Durability
- Low Seam Strength
- Limited Designs

Double Layer

(OT 25-50 PLI)

Advantage

- Higher FSI
- Good Stability
- Longer life
- Improved Retention

Disadvantage

- Higher Cost

Triple Layer

(OT 30-80 PLI)

Advantage

- High Drainage
- High formation
- Most Durable
- High Retention
- High Stiffness

Disadvantage

- Higher Void volume
- Higher Cost

Trends In Tissue Forming Fabrics

Triple Layers - Dominant Tissue Design

Triple Layer Advantages

- Ability to have fine sheet side and durable machine side
- Engineered drainage potential
  - Can control drainage rate with weave design
  - High drainage rate potential – straight through drainage
- Increased mechanical retention
- High fabric stiffness and width stability
  - Reduced CD profile variation
  - Stable width for use in Crescent formers with trim beads
- Long life potential
  - Large machine side wear strands
  - Durable and damage resistant
- Easy to clean
  - Excellent shower penetration – with straight through drainage holes

Tissue Forming Fabrics – Position Application

Triple Layers

- Twin Wire Outer positions – Stiff, fast drainage, high support
- Inner positions suction roll – Thin, high support
- Crescent Formers – Stiff, width stable, high support
- SBR – Thin, fast draining, high support, low water carry

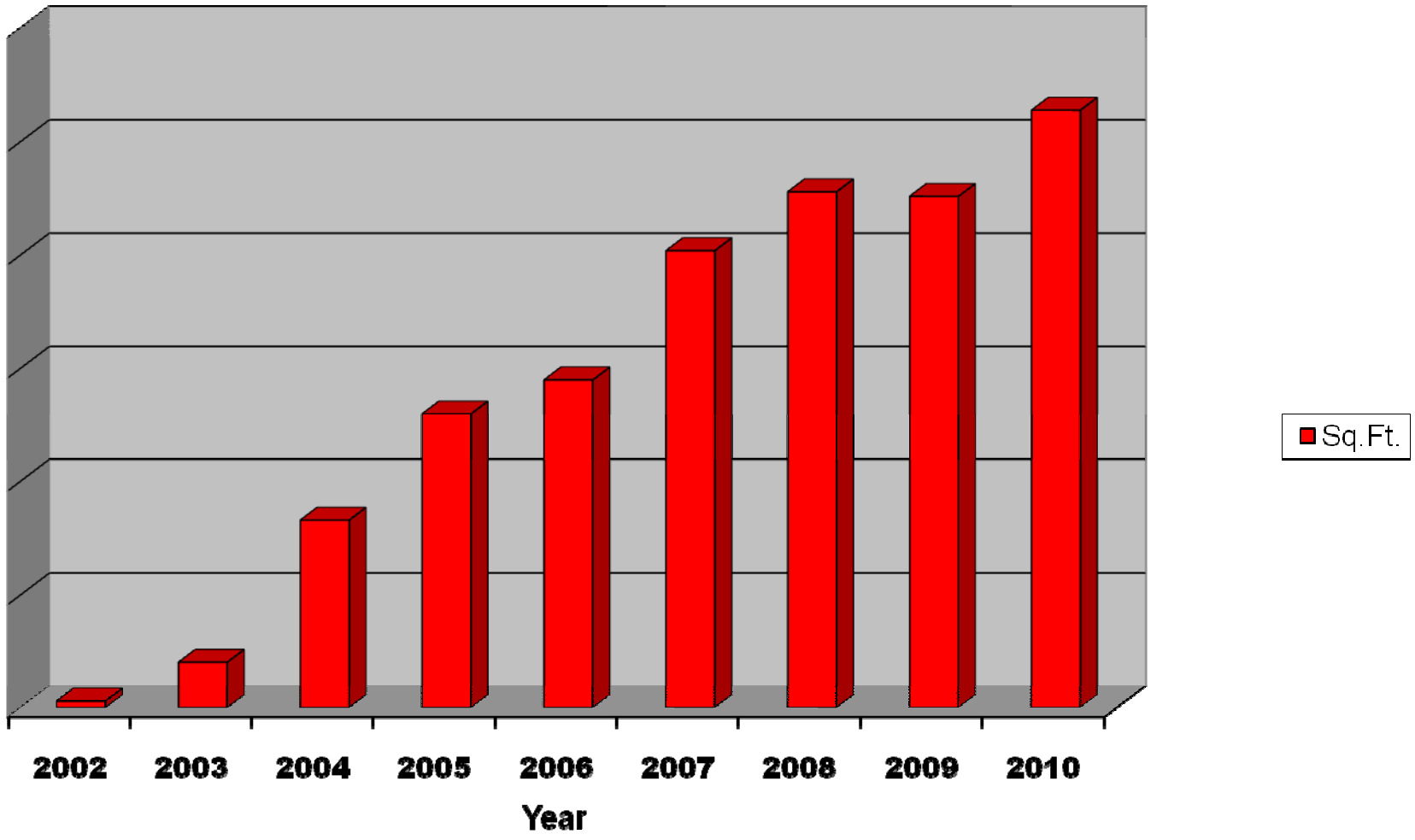
Double Layers

- Twin wire Inner positions – Support and durability
- SBR – Ultra Fine, thin, high support

Single Layers

- Inner position transfer fabrics

Triple Layer Tissue Sales Growth



Tissue Triple Layer Designs

Intrinsic Weft Tied (SSB)

- High Drainage Rates
- Superior CD Profiles – High Stiffness
- Higher Caliper
- Best Dimensional Stability
- No Delamination
- Strong Seam

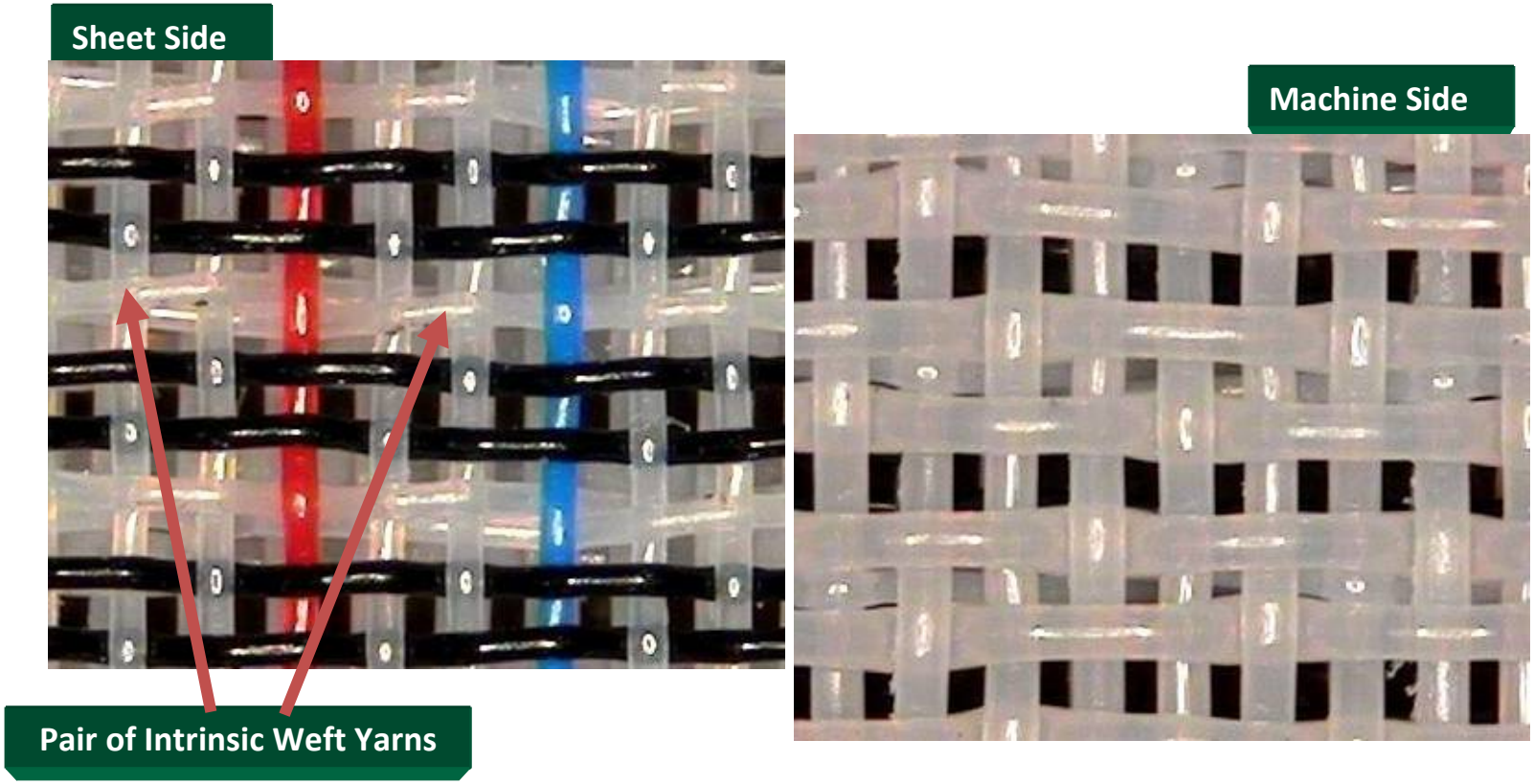
Warp Interchange / Warp Tied

- Reduced Fabric Caliper
- Lower Drainage Rates
- No Delamination
- Efficient to Manufacture – Lower Cost

•Conventional Tied

- Prone to Delaminate

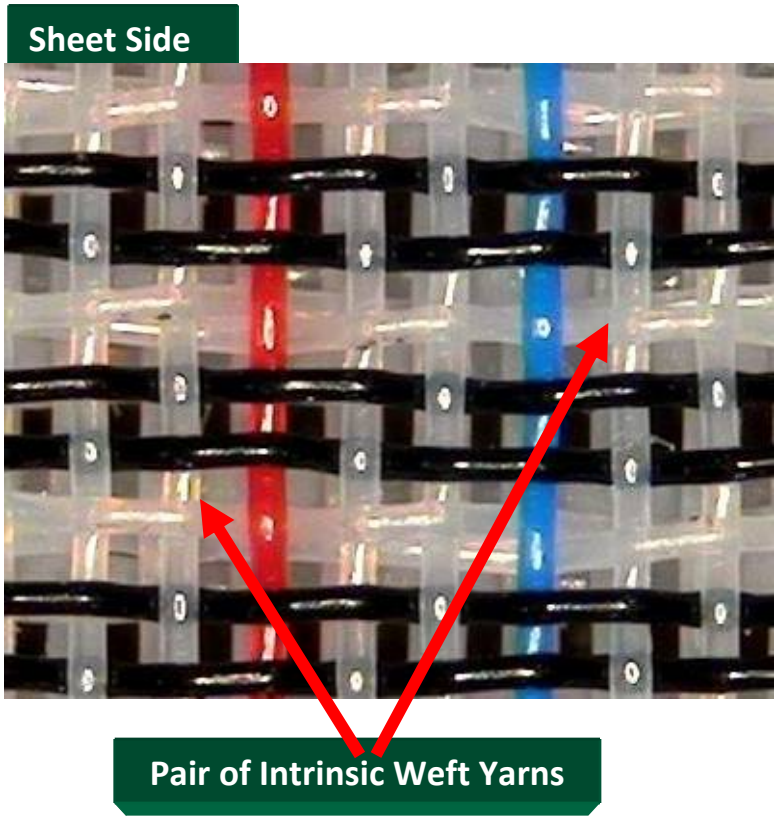
Tissue Triple Layer Designs



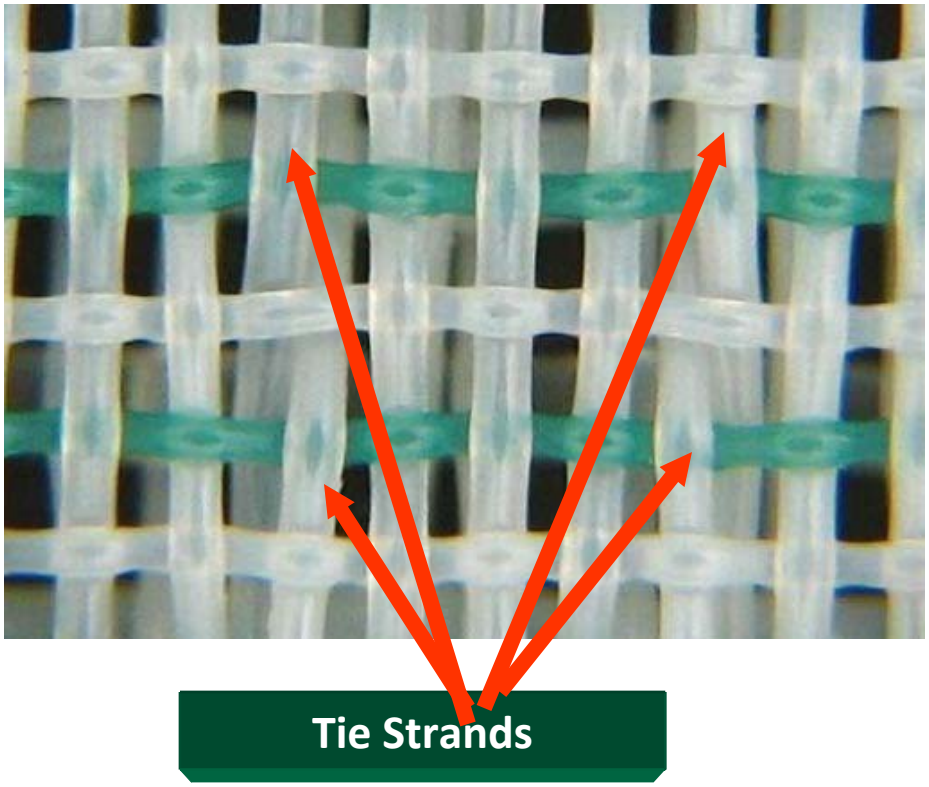
3-Shed Top, 4-Shed Bottom Weft Tied SSB Triple Layer Tissue Forming Fabric

Tissue Triple Layer Designs

Intrinsic Weft Tied (SSB)

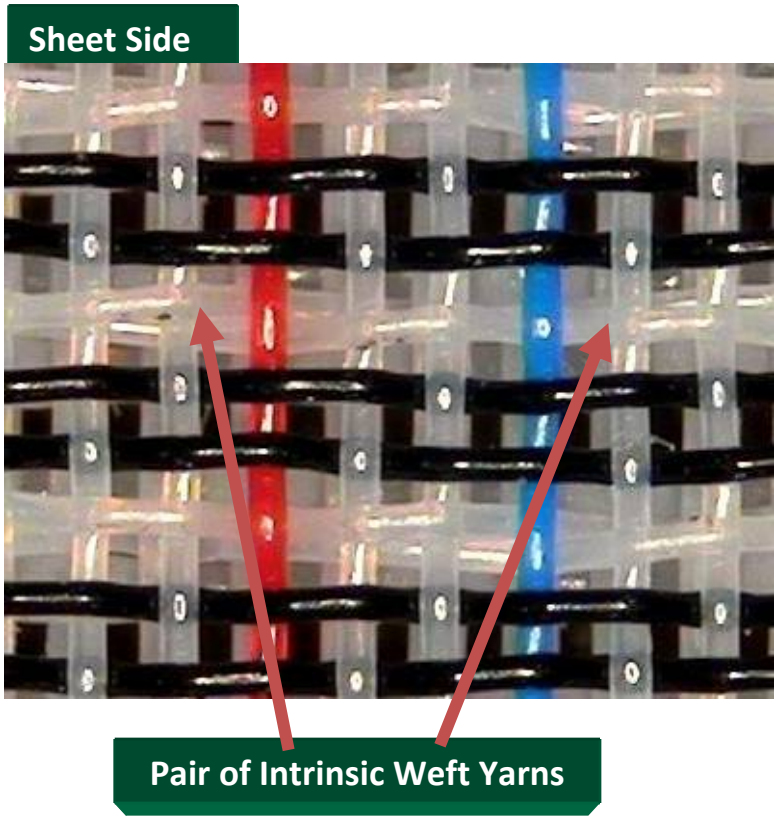


Warp Interchange / Tied

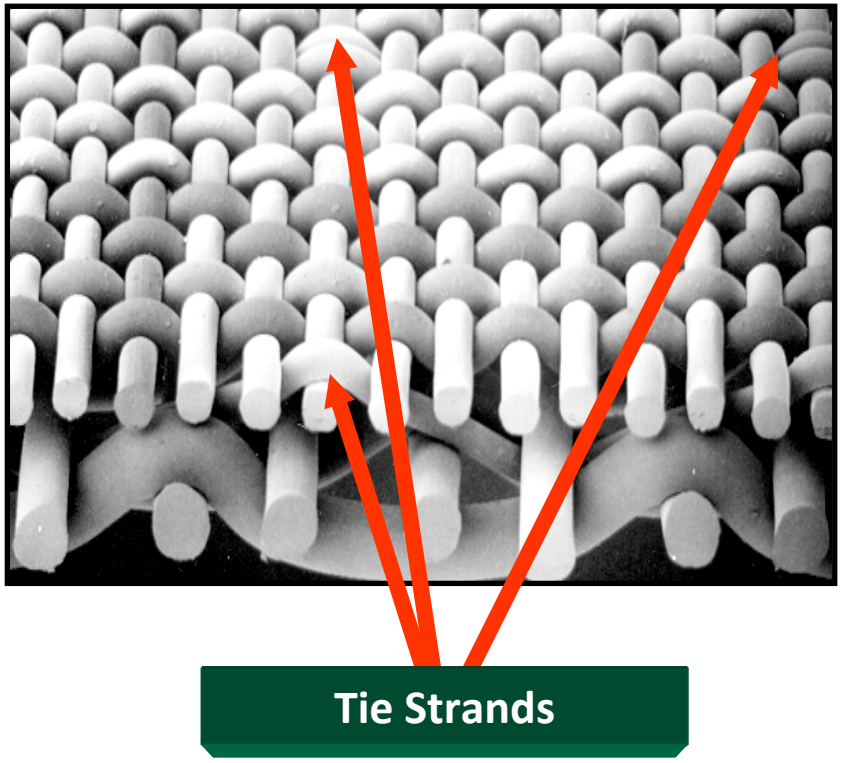


Tissue Triple Layer Designs

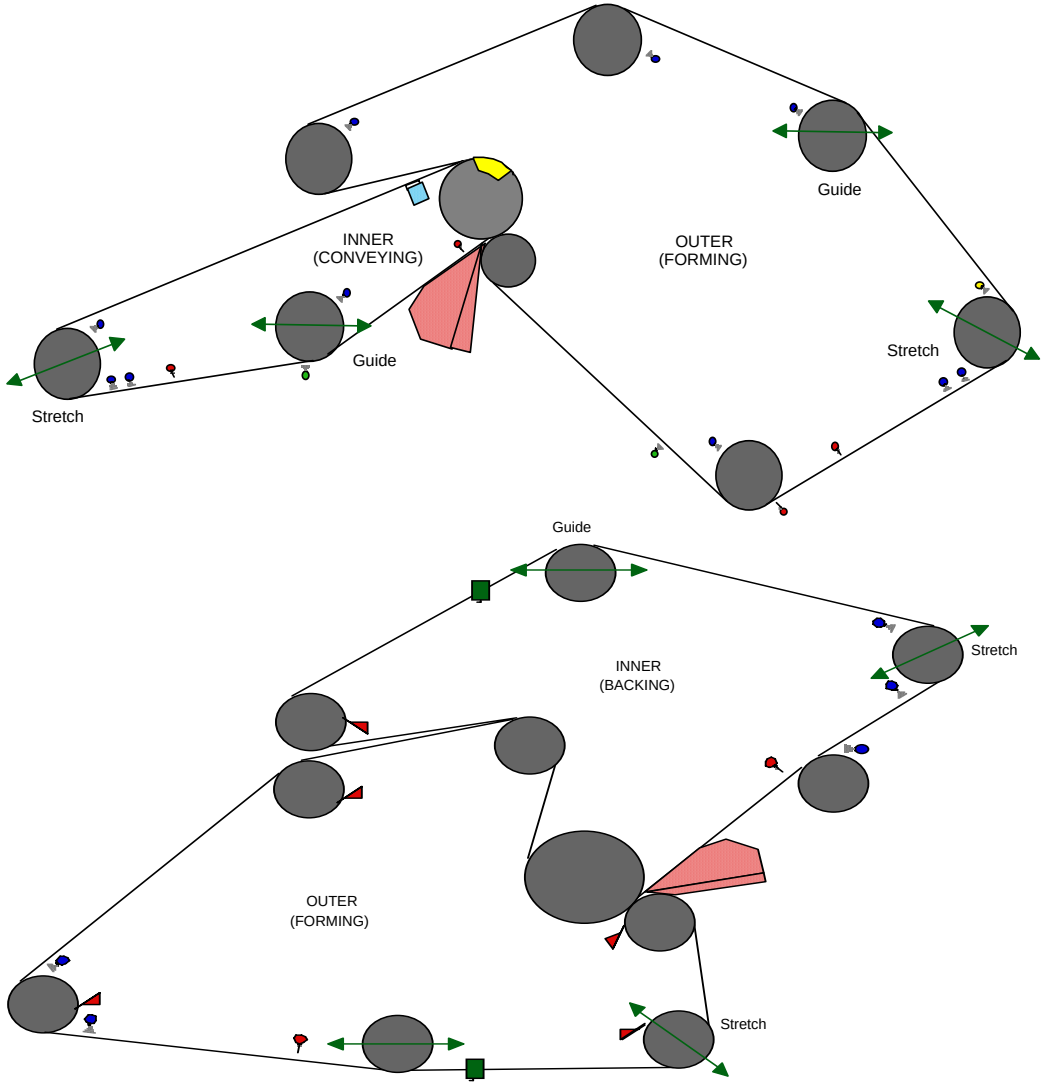
Intrinsic Weft Tied (SSB)



Conventional Tied



Twin Wire Former



Fabric Requirements

Outer Position:

Fast Drainage

High Fiber Support

High Fabric Stiffness and Stability

Low Fabric Stretch

Easy to Clean

Inner / Backing :

Easy to Clean

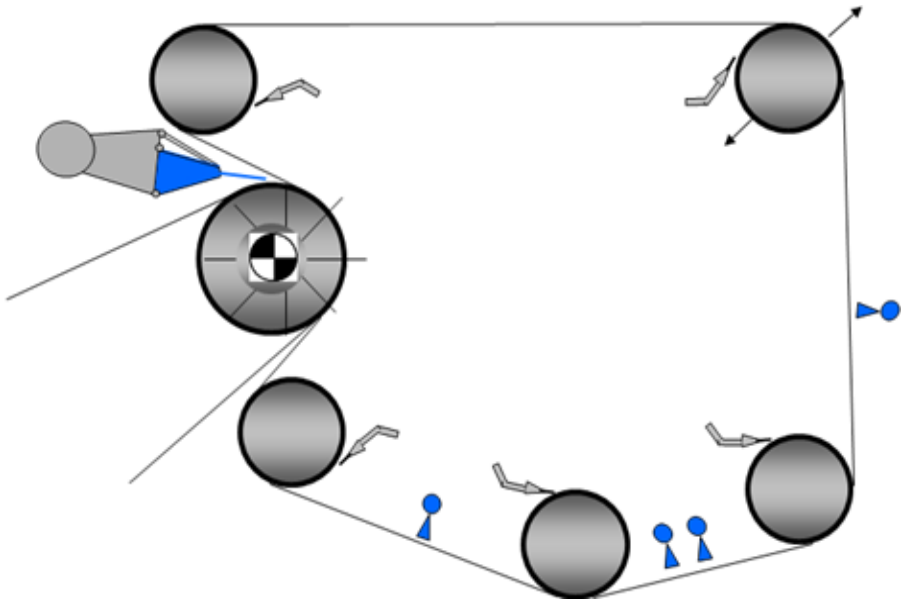
Low Fabric Stretch

Good Durability for Life

High Fiber Support

(c-wrap TAD and Suction)

Crescent Former



Fabric Requirements

Width Stability – Sheet Width Control

High Fabric Stiffness – CD Profile

Fast Drainage – High Speed Operation

High Fiber Support- Formation and Retention

Low Fabric Stretch – High Tension Operation

Easy to Clean – Efficient Showering

Low Water Carry back – Dry Return Run

Suction Breast Roll Former

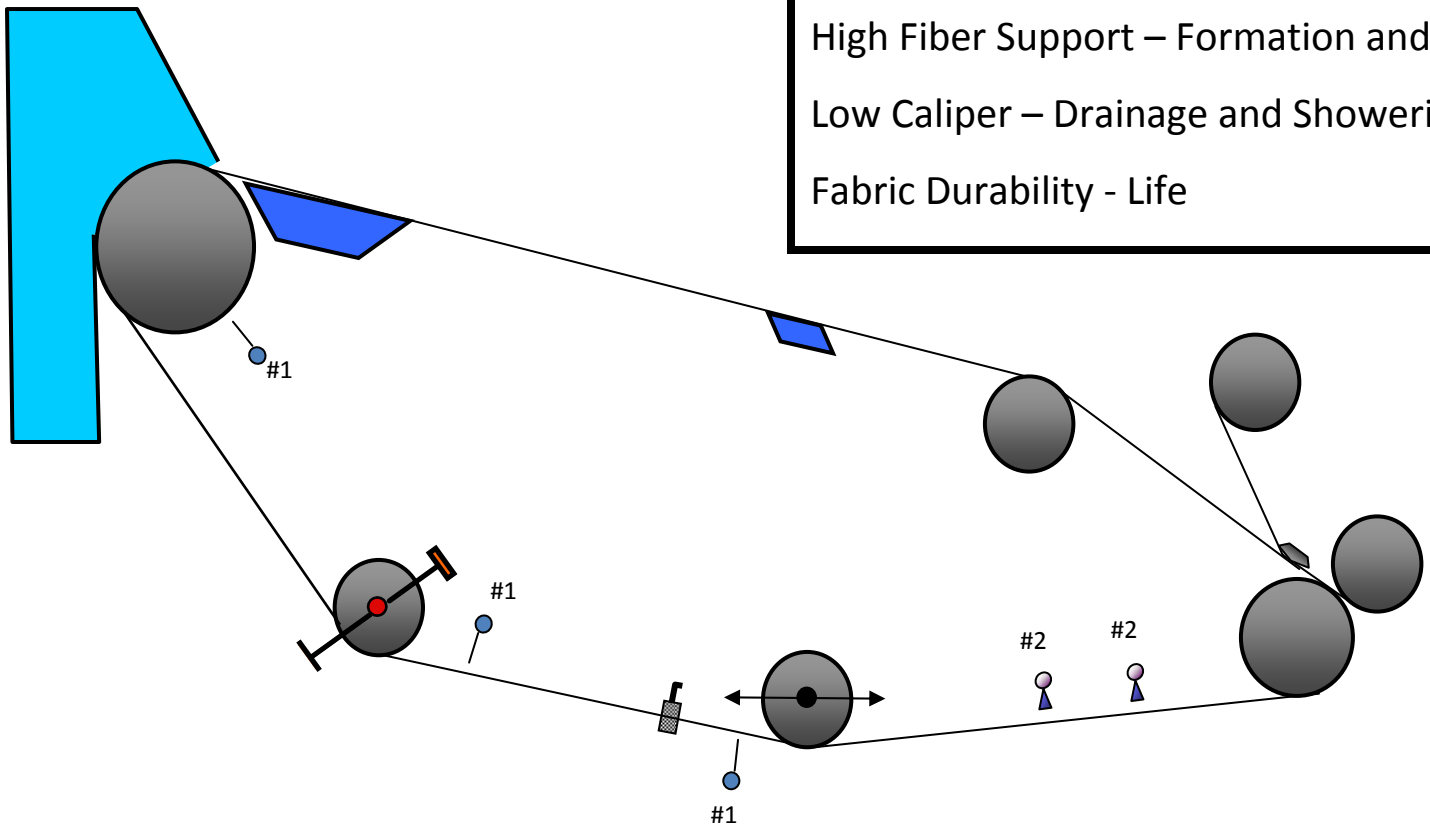
Fabric Requirements

Fast Drainage – Very Short Forming Zone

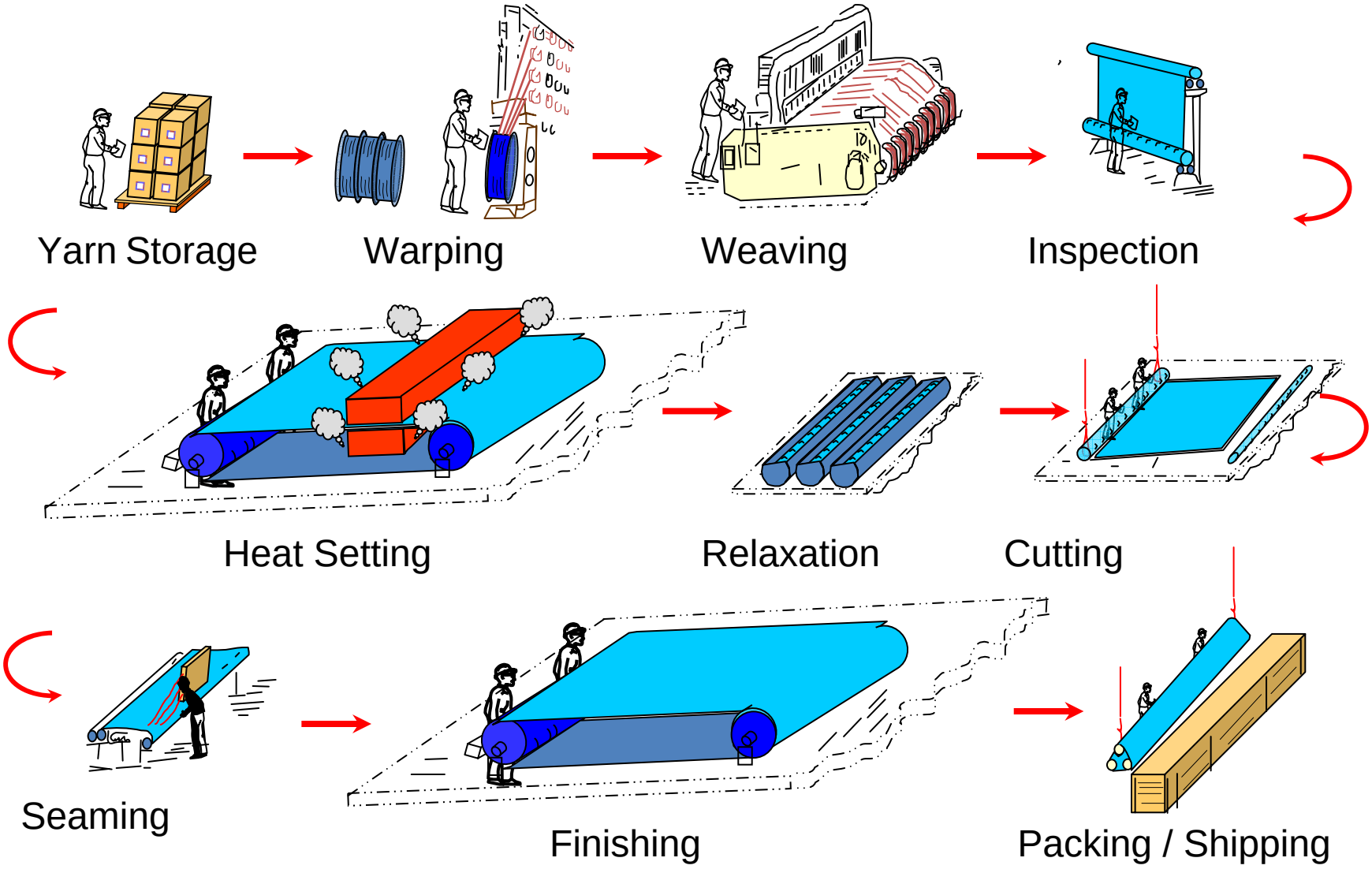
High Fiber Support – Formation and Retention

Low Caliper – Drainage and Showering

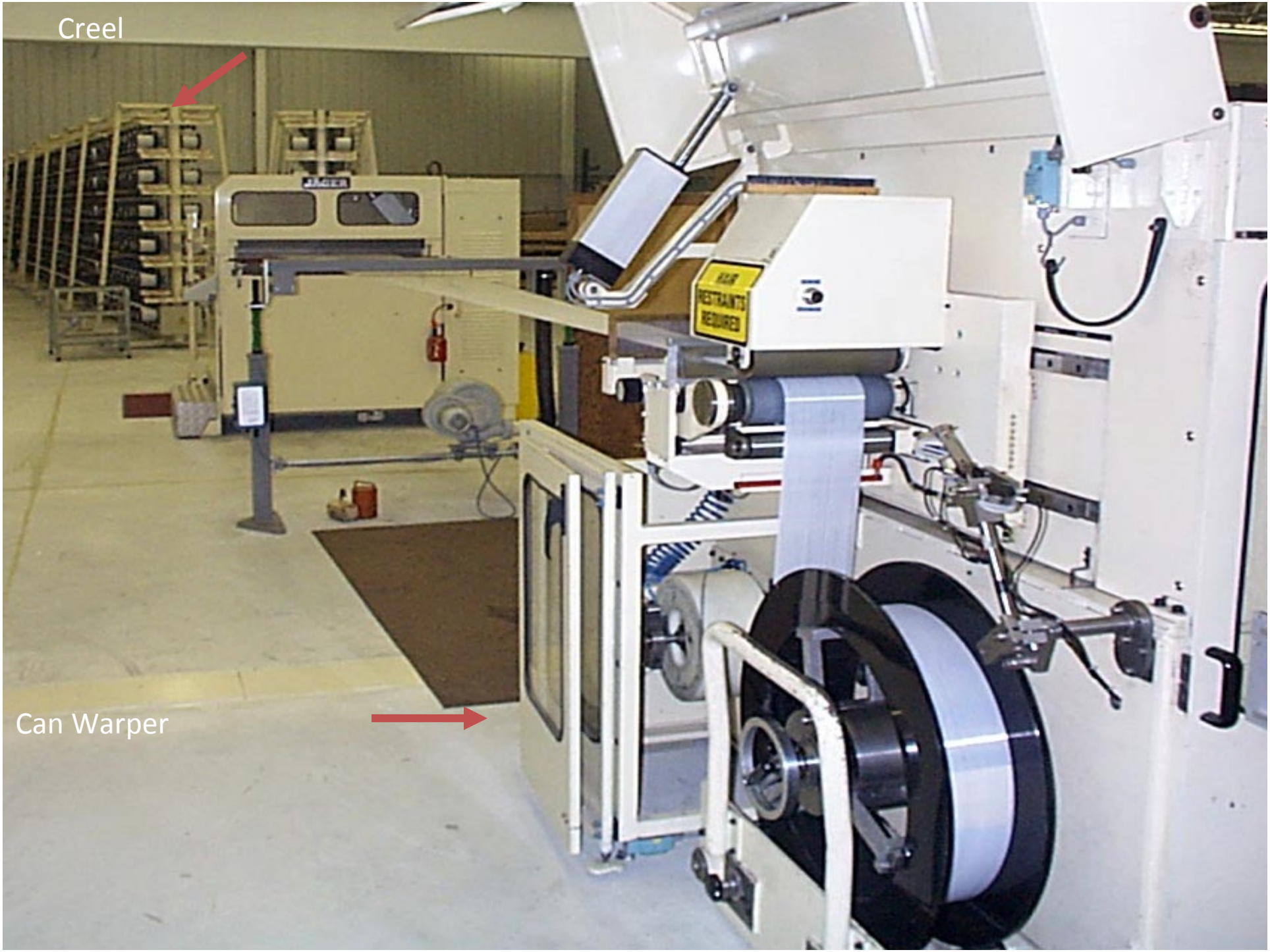
Fabric Durability - Life



Forming Fabric Production Processes




Strand spools
ASTENJOHNSON
SHUTE


Creel
Can Warper


8” Cans
Single beam warp

TAD Fabrics

TAD Fabric Designs

M-Weave

G- Weave

Multi-Layer Shaping

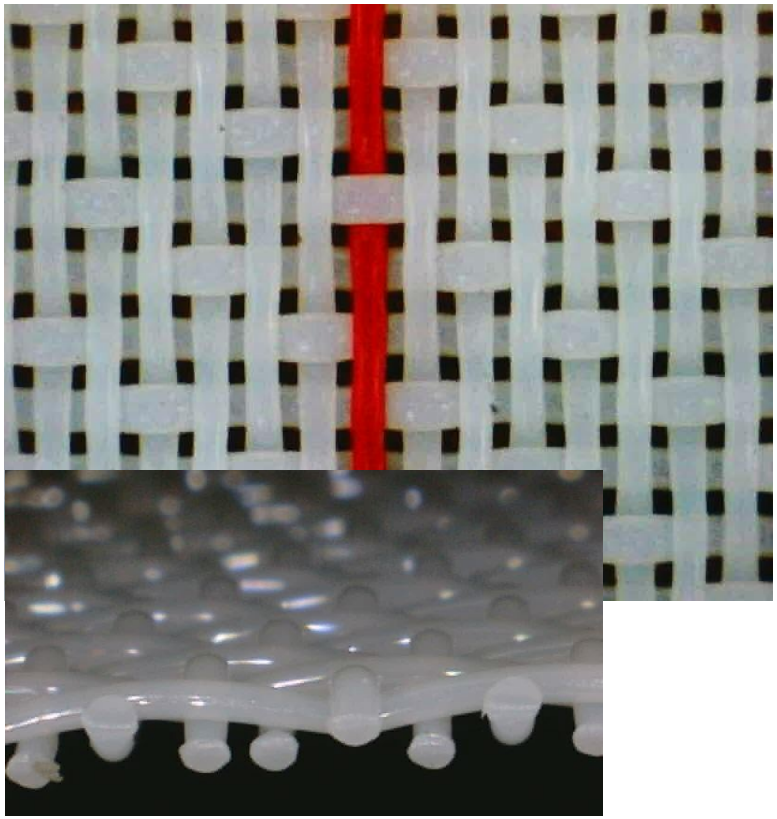
TAD Fabric Designs

- Most conventional TAD fabrics are based on 5-shed, single layer, 44 mesh warps
- 36 and 50 mesh warps also used
- M-weave used most on Bath Tissue
- G-Weave used most on Towel
- New Multi-layer Shaping designs entering market

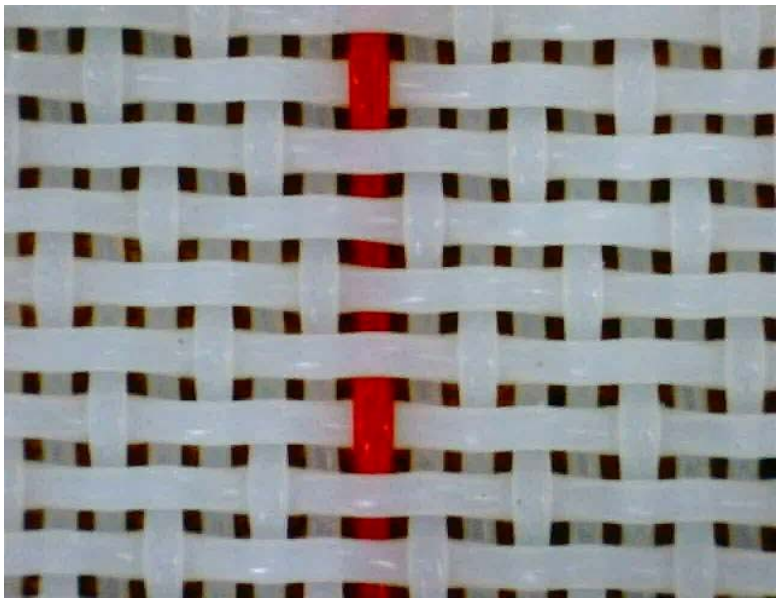
44 M-Weave

Used Primarily for Bath Tissue
Medium bulk generation
Good softness

Sheet / Yankee Side



Machine Side

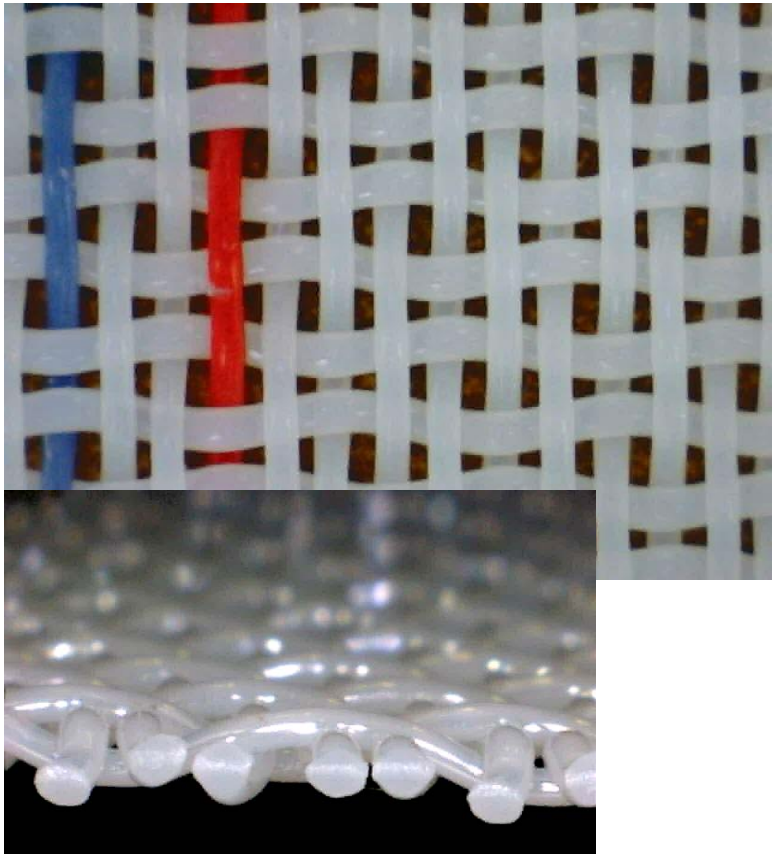


44 G-Weave

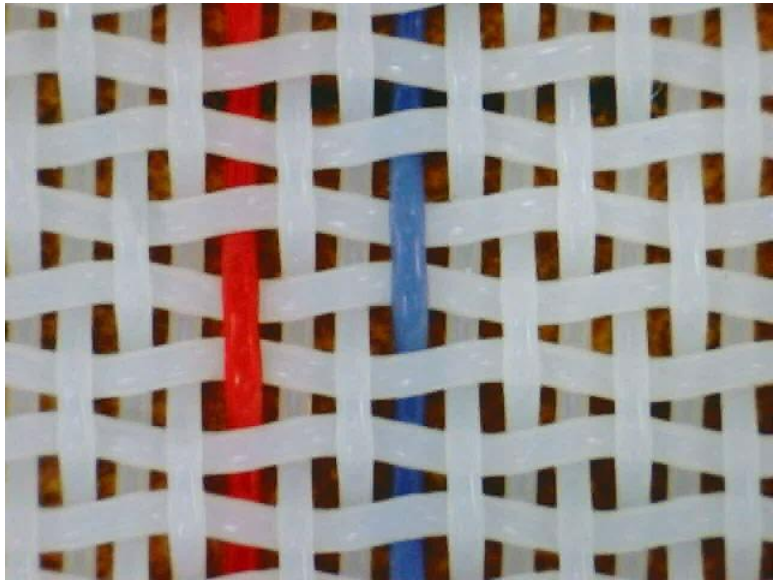
Used Primarily for Towel Production

Increased bulk generation

Sheet / Yankee Side



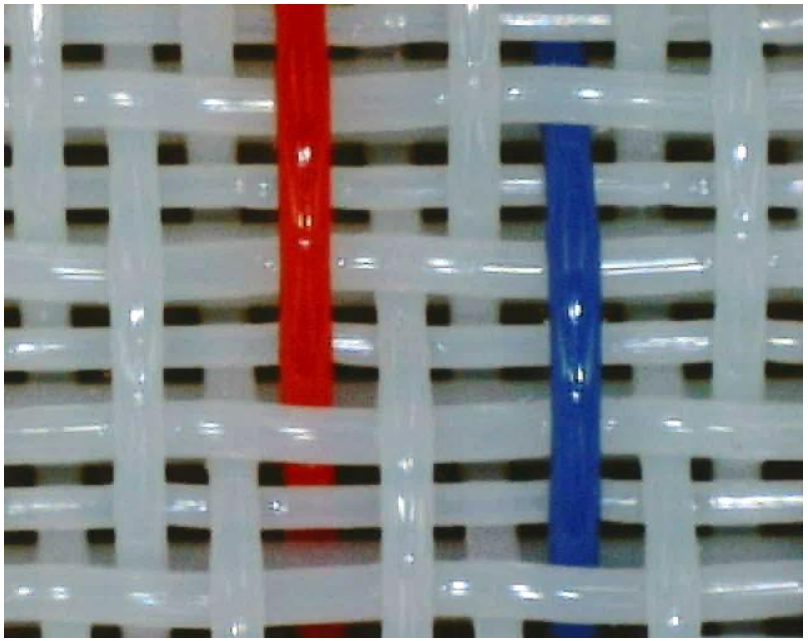
Machine Side

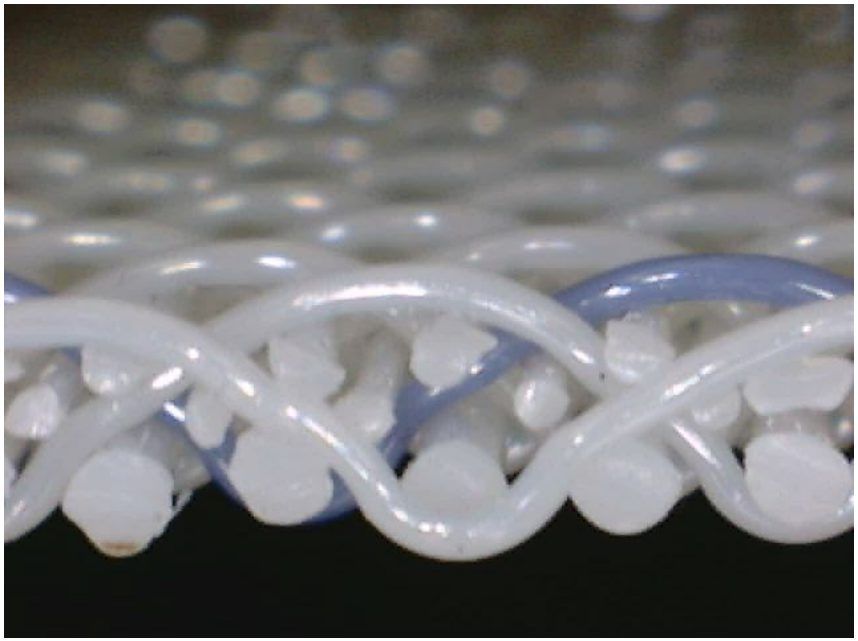


Multi-Layer Shaping

Customize sheet impression
Able to develop increased bulk and softness
Increased durability and life potential

Sheet / Yankee Side





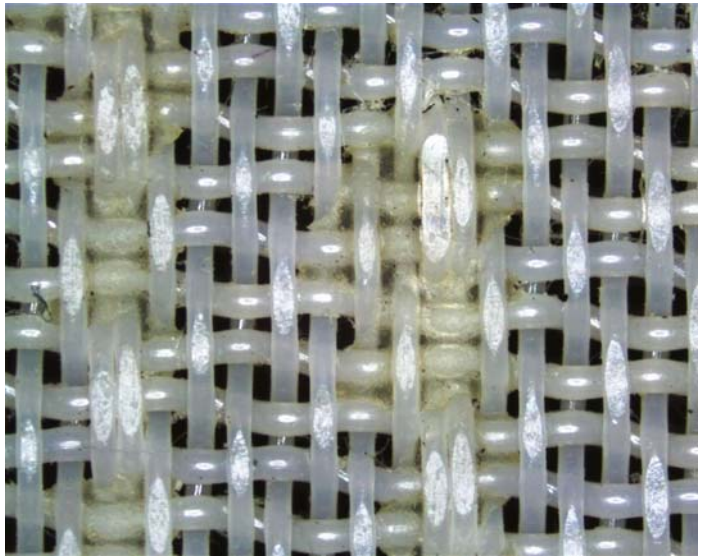
TAD Seam Development

- New Technologies able to increase seam strength and reduce seam width
- Seam no longer limiting factor for weave design or fabric life
- Laser Welding
- Ultrasonic Welding

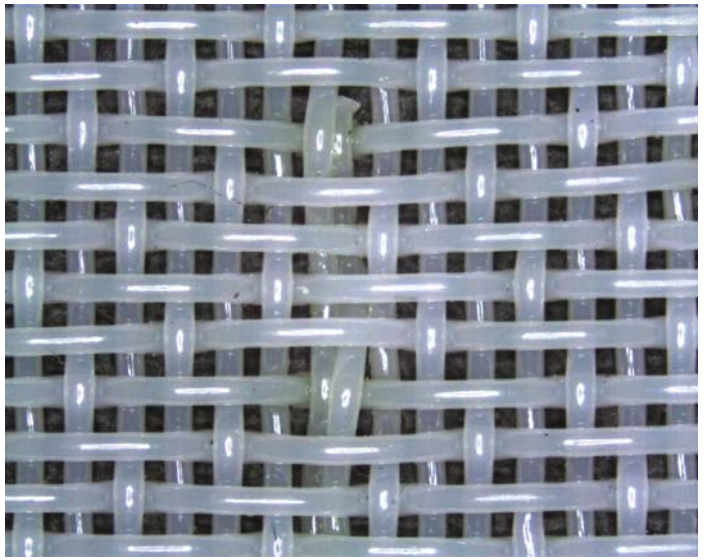
Benefits of Laser Welding for TAD

- Significant increase in seam strength
- Reduce seam width by 50- 70%
- Seam area permability consistant with body of fabric
- Design Flexibility
  - Seam strength no longer consideration in weave design
  - Customize weave to produce unique pattern in sheet

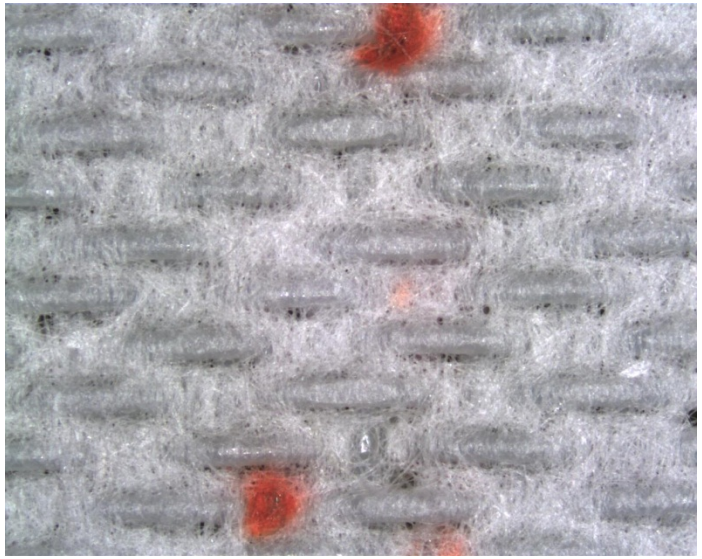
Glue vs. Laser Weld



Glue vs. Weld



Glue vs. Weld



Air perm in the glued seam area is averaged 480cfm and 590cfm in the cloth area.