Web 101.73SM – When to Move
Roller Alignment - Standards

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Why is Alignment So Important?

Affects the Web:

- Flatness: Bagginess and apparent Bagginess
- Position: Path and Registration (e.g. Printing)
- Runnability (Web Breaks)
- Winding: Roll Quality
- Wrinkles
Two Views of Alignment

• Mechanical
  – Level
  – Square
  – Common Centerlines
  – See Web101.72
  – Roller Alignment - Mechanics

• Web Handling
  – In-plane (bending)
    • Path control
    • Web breaks
    • Wrinkles
  – Out-of-plane (twisting)
    • Web damage or breaks at edges
    • Center wrinkle
  – Offset Centerlines
    • Guide runs off center
    • Web runs off center
In-Plane Bending

- a.k.a., i.e.
  - Not parallel
  - Not trammed

- THE MOST SERIOUS RISK
  - Path Control
  - Web breaks
  - Wrinkling
  - etc
In-Plane Bending: Stresses-Strains

- **Physics:**
  - **Normal Entry Law:**
    - Web enters a roller in traction at a right (normal) angle

- **Explains**
  - Guides
  - Roller Misalignment
  - Spreaders
  - etc

- **Can Cause**
  - Web Breaks
  - Slack Web
  - Wrinkles
  - Path Change
  - etc
Out-of-Plane Twisting

• a.k.a, i.e.
  – Twist
• Very Tolerant
  – Difficult to Overstress
  – No path change
• Applications:
  – Displacement Guide
  – Some Dual Spreaders
Out-of-Plane Twisting: Stresses-Strains

- No Path Change
- High Stresses at Edges
- Center MD Bagginess/Wrinkle possible
Emergency Alignment

- Wrinkles are found at roller #3 and cause the web to break
- Question: **Which roller** (1-4) should be moved in **which direction** (horizontal, vertical, other)?

**Hint:**
Practical Alignment

• Which rollers and directions is alignment most needed?
  – Level – easy
  – Square – requires optics
Existing Alignment Guidelines

- **Categories**
  - **None** – great majority of builders, suppliers and owners of web machinery
  - **100 micro-radians**
    - (0.1 mm per meter)
    - Converting builders
    - Roller builders
    - Consultants
  - **20 micro-radians**
    - Paper mills (dry end)
  - **5 micro-radians**
    - 1st order optical tooling

- **Problems**
  - Few subscribe to anything
  - Paper mill (optical) alignment based on what we could do instead of what we should do
  - Single sided
    - Ingoing (if you move)
    - Outgoing (when you move)
  - One size fits all may fit most poorly
Calculation Based

- For Each Critical/Typical Roller, Web and Direction
  - Path Control
  - Web Breaks (Critical Angle to Inside Edge Slackness)
  - Wrinkling (Critical Angle to Diagonal Shear Wrinkle)

Gehlbach, Lars S. and Good, J.K and Kedl, Douglas M.
TopWeb

- Rheologic Spreadsheet Calculation Tools
- Only Commercial Web Handling Program
  - Roller alignment
  - Spreader Sizing
  - Winding
  - etc
- Calculate Angle
  - Before Edge Goes Slack
  - Before Diagonal Wrinkling
TopWeb – Roller Align etc
Empirical

- For Each Critical/Typical Roller, Web and Direction
  - Wrinkling (Critical Angle)
- Move roller while running, observe when diagonal wrinkle starts

Points to Narrow side

Walks ‘Uphill’
A Question of Safety Factors

• For Each Critical/Typical Roller, Web and Direction
  – Path Control
  – Web Breaks (Critical angle to Slackness)
  – Wrinkling (Critical Angle)

Having No Safety Factor Guarantees Instant Failure

• Insults are additive
  – Bagginess
  – Roller delta D
  – Roller Misalignment
  – Drive/Tension delta

Mean Distance Between Breaks (ft)

Web Tension Load (PLI)

± ± Confidence Envelope
Based on data set variability only. Does not include model uncertainty.
Ingoing Suggestions

- Ingoing (when rollers are moved)
  - Installation
  - Maintenance
  - Response to problems
    - Path
    - Web Breaks
    - Wrinkle
- 20 micro-radians
- Design for Service (Alignability)

- Unless
  - You Know Better
  - You Need Better
    - Foil
    - Segmented roller gaps
  - You Can’t Get (Afford?) Better
    - See upcoming slide
Outgoing Suggestions

• Outgoing (*Should* rollers be moved?)
  – Response to known misalignment problems
    • Path
    • Web Breaks
    • Wrinkles (diagonal)
• Calculate or Measure ‘threshold of pain’
• Safety factor of 4-10
  – Similar to tension

• Classes
  A – < 20 micro-radian tooling, brittle webs
  B – 20 micro-radian paper, metal
  C – 100 micro-radian converting
  D – 1000 micro-radian rubber, textiles
  F - > 1000 micro-radian web handling fail
A Few Challenges

• **Design**
  – Bearing housings at angle
  – Bearing housing that have no shear ledge
  – Bolt bound designs

• **Rollers**
  – Poor maintenance
  – Loose mounts
  – Flimsy frames

• **Special**
  – Pivoting rollers
  – Curved axis rollers
  – Skew rollers

• **Web**
  – Foil

• **Management**
  – Insufficient Time
  – No money
  – Culture
  – Lack of Guidance
Review Questions

• What are the web based definitions of misalignment?
• What methods might you use to establish a threshold of pain?
• What about a safety factor?
Review Answers

• What are the web based definitions of misalignment?
  – In-plane bending, out-of-plane twisting, offset centerlines

• What methods might you use to establish a threshold of pain?
  – Move/measure roller to onset of wrinkling, calculate via TopWeb

• What about a safety factor?
  – Above guarantees instant failure, need to be 4-10X tighter
Questions?

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