Guidelines for Rolls Used in Web Handling

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Challenge in **Web Handling**

Convey the Web Straight through the Process Without Defects such as Wrinkles
ALL Web producing and converting lines

Require the use of idler rolls, pull rolls, tension rolls, spreaders and edge guides in order to control a web as it is being conveyed.
Without the correct size and application of these components, web conveyance with proper tracking without wrinkling will be a real challenge!
Goal of this presentation-

Provide General Guidelines for selecting **Idler Rolls, Pull Rolls, Spreaders and Edge Guides** for successful web conveyance without defects
Web Tension

In A Perfect World - Would not need **Web Tension**

Float The Sheet **Straight** Through the Line Without Generating Wrinkles
Unfortunately- In a Real World

Rollers *are not Perfect*

Webs *are not Perfect*
WHAT ARE THE CHALLENGES OF WEB HANDLING ROLLER DESIGN?
Web Handling Rolls

DESIGN CONSIDERATIONS

• Having the Right Roller Material
• Having the Right Roller Diameter
• Having the Right Roller Bearings
• Having the Right Roller Spacing
• The Challenges of Air Greasing
• Web Handling Roller Alignment
Roll Materials -

Chrome Plated Steel - *Normally Used with Paper & Paperboard*

Anodized Aluminum - *Used for Films, Light Paper & Aluminum Foils*

The cost of Steel and Aluminum are about equal

Trends for thinner materials and higher speeds require –

Carbon Fiber Composite Rolls which are:

+ Less weight & inertia
+ Higher Critical Speeds
- Less Durable than Metal
- **Carbon Fiber Rolls are More Expensive**

However, Costs are Coming Down
IDLER ROLL DIAMETER

Roll Diameter

- Generally $\frac{\text{LENGTH}}{\text{DIAMETER}} = 16$ or Less, i.e. $1.5\text{M} = 100\text{mm dia}$
- Paperboard or Stiff Material, Consider Bend Radius
- Unloaded Roll Deflection, *Rule of Thumb*:
  
  Generally $0.15\text{mm per each 1 Meter of Roll Face}$
IDLER ROLL BEARINGS
Low friction seals & Keep bearing. size to Min.

Dead Shaft Type

- Usually Less Expensive
- Lower Inertia
- Greater Deflection (Not for Wide, High Tension Applications)
- No Bearing Re-Lubrication
- Difficult Bearing Replacement
- Requires Larger Diameter bearings (journal sag w/ sm. dia.)

Live Shaft Type

- Less Deflection due to Head Stiffness and Larger Journals
- Bearings Out in the Open
- Bearing Size Not Limited
- Bearings Easily Lubricated
- More Expensive
- Greater Inertia
“Rule of Thumb” -

- 2/3 Max. Web Width
- *Thin (8.5 um) Aluminum Foils*, use .6 Meter max.
  - Longer spans if a Spreader roll is used after the longer span.
- Roll Spacing is Speed / Tension Influenced
- Web Flutter - Shorter distances between rolls
Air Greasing

Tracking & Web Scratching Problems

Air Entrainment Principles
- Roll’s and Web’s Surface Do Not Affect Air Layer
- Larger Roll Diameters Entrap More Air
- Smoother Rolls Will Lose Traction Easier & Scratch Web

Possible Solutions
- Rougher Roll’s Surface
- VentAir Groove Roll’s Surface
Web Handling Roller Alignment

Another *Rule of Thumb* –

Rollers Should be Level & Tram within 0.1mm/meter (0.010”/100”)

- Greater Allowable Misalignment for Extensible Materials (stretchy films)
- Less Allowable Misalignment for Thin, Non-Extensible Materials (aluminum foil)
Other Web Handling Roller Considerations:

• Roundness (TIR)
• Roller Straightness
• Dynamic Balance

Reference Book
“The Mechanics Of Rollers”
Dr. David Roisum
TAPPI Press
Guidelines for selecting proper idler rolls

By R.紫外光, product manager, specialty winding, Davis-Standard Converting Systems

Abstract
All web processes require conveying a web straight through a process without distortion or defects such as wrinkles. A converting process or film producing line requires the use of idler rolls to provide control of the web as it is conveyed. The selection of idler rolls involves a simple task at first glance; however, today’s web producing and converting lines often must handle a wide variety of substrates resulting in wide tension ranges at ever increasing maximum speeds. The design considerations for web-handling idler rolls include selecting the right idler material, diameter, bearings and rolls’ surface. Then, the proper roller spacing and alignment need to be determined to successfully convey a paper, film, foil and/or nonwoven web material. This paper addresses these considerations to help ensure the ability to consistently produce a quality web product, which will ultimately improve productivity and profitability from the production line.

Idler-roll material
The most common roll material for film, aluminum foil, lightweight paper and extruded nonwoven substrates is aluminum, which is sometimes anodized to give it a harder surface. The aluminum roll is lightweight, easy to machine and does not rust.

Paper and paperboard usually require a steel roll that is chrome-plated. The higher modulus of elasticity of steel produces less roll deflection for running higher web tensions and higher nip velocities. Steel, being much harder than aluminum, is more durable and less prone to be damaged during normal use and cleaning. However, a steel roll is heavier than the aluminum roll with a greater inertia (K/I) resulting in more tension being required to accelerate and keep the roll turning.

The cost of aluminum is greater than steel, but the machinability of it is also better, so the overall cost of these rolls is about equal.

Stainless-steel idler rolls are required where the substrate is used, such as in the photographic industry or other corrosion applications. Some coatings, PVDF, for instance, attack aluminum or mild steel and require stainless steel in the area of the coating.

Carbon-fiber composite rolls are used in high-speed and light tension applications where lightweight, non-metal rolls are required. The primary advantage of this material is that it weighs less than half that of aluminum and it is stiffer, resulting in a roll that runs easier and has a greater critical speed. Carbon-fiber material is less durable than aluminum or steel and is often covered with a metal, plastic or thermoset sleeve. The sleeve itself is more expensive than conventional metal rolls due to material and manufacturing costs, which require diamond or carbide tooling. However, due to lower inertia, if a mechanical or electrical drive can be eliminated, the overall cost may be less.

Idler-roll construction
Two designs cover the idler rolls in converting lines. The dead shaft roll and live shaft roll (see Figure 1). Both designs have their place on converting machinery with the selection often determined by customer or machinery builder preference. Following is a comparison of these two types of roll construction.

Roll cost – The dead shaft design, especially in lengths under 100 in, and roll diameters up to 6 in, is considerably less expensive.

Bearing size – The dead shaft design can use smaller hollow bearings because the shaft does not rotate; thus reversal of journal faces does not Exist. Smaller bearings mean less bearing friction, but also less bearing life.
Challenges in Web Handling

Rollers are not Perfect
Webs are not Perfect

• Easy to Align Web Handling Rollers to 1 PART IN 10,000 (0.1mm / 1000mm)
• Difficult to Manufacture Webs to 1 PART IN 100 (1% Across Sheet)

Web Producer’s Challenge - Make Web Basis Wg. Profile as Flat as Possible

— Basis Wg. = f(thickness & moisture)
Question-

How much **Web Tension** should I use?

**Answer:** As Little as possible to convey Imperfect webs straight through a process without wrinkling.
The most costly defect in Web Handling is: **WRINKLING**

Wrinkles

Wrinkling is the number one cause of defect waste in the web industry. This subject is so important that a complete chapter has been written on WRINKLES by Dr. David Roisum in the new TAPPI book - *Roll and Web Defect Terminology*. Please go to this link for more information on this book.

Wrinkles can be soft (non-creased) or hard where they actually fold over and form creases. They are Man, Material and/or Machine induced. Most wrinkles are a combination of these elements.

Wrinkles caused by Man (improper settings) can usually be attributed to improper web tension and/or winding settings. Wrinkles can form in the web in the process line by running tension settings (Mm) that are too low or too high in combination with Material and Machine deficiencies. Roll wrinkle defects, such as Buggy Lanes, Buckles, Corrugation Wrinkles and Crepe Wrinkles, are caused by improper roll structure settings (improper use of the Tension, Nip, or Torque roll structure tools) or the winding of non-uniform webs too tightly into a roll form.

Wrinkles caused by Material are due to non-uniform formation, conditioning, coating, drying and/or laminating in the web’s process history. The root cause of many wrinkles is the non-uniformity in the cross machine direction surface of the web. Since no web is perfectly flat or uniform across its surface, our challenge as Web Processors is to handle webs with acceptable variations in consistency and to produce wrinkle free products to our customers that will run on their processes without problems.

Wrinkles caused by Machine deficiencies are the focus of this Tech Tip. Many times Material deficiencies, which produce soft wrinkles, can be turned into hard or creased wrinkles when the web goes over a highly wrapped idle roll or through a nipped section.

**Tech Tip on Wrinkles – Give me your Email**
How much **Web Tension** should I use???

Dr. David Roisum’s “*Rule of Thumb*”

10 - 25% of the Web Material’s Machine Direction Tensile Strength
Web-tension guidelines for polymer films, papers and cardboard webs

By R. Duane Smith, product manager — Specialty Winding, Davis-Standard Converting Systems

Abstract

Web conveyance is a requirement that transcends many industries. The requirement is to convey a web flat and straight through the process without generating defects such as wrinkles. To accomplish this, the web needs to be assisted under a certain amount of force commonly referred to as web tension. The article provides guidelines for calculated amounts of web tension that should be used to convey certain types of materials common in the paper, paperboard, polymer films, extrusion-coating, and fibrous-packaging industries. In general, for web conveyance, the actual web tension should be as little as possible to convey a web flat through the process without wrinkles from lack of traction on web-driven rolls and/or without wrinkling. The values of tensioned webs are general guidelines and the actual web tension should be kept at or below those values.

With handling being a new challenge, we need to convey a web flat and straight through the process without generating defects such as wrinkles. To do this, we need to convey the web under a certain amount of web tension. The question then becomes: How much web tension do I need to ensure success in producing a web product without defects that will result in customer’s loss and that will meet the expectations of the customer’s customer for the material that we produce?

The basic answer: As little as possible. In a perfect world, we would not need to use web tension. We would simply feed the sheet straight through the process without wrinkling or bagging defects. Unfortunately, webs are not perfect, and wrinkles are not free. Therefore, we need to use some tension to successfully convey webs through a production line. The suggested maximum web tension presented in this paper are guidelines. Last, remember, in almost all cases, more web tension is usually not better.

Because no web is perfectly flat, we need to convey flat, tight webs. The suggested amount of web tension is typically between 10 and 25 percent of the web material’s tensile strength for flat tension when dealing with woven materials. For example, if a web takes 10 lb of tension in a 1-in. web to tear, it will break or permanently set. From the suggested amount of web tension to convey a web, it would be 10 percent of this number or 1 lb/100 in. of tension with a maximum tension of 2.5 lb (25 percent of the elastic limit). Plastic and paper technical organizations such as Society of Plastic Engineers (SPE) and the Technical Association of Pulp and Paper Industry (TAPPI) have done studies and gathered a lot of empirical data on the suggested amounts of web tension.

Web tension for polymer films

SPE and the PLACE Division of TAPPI suggest that the maximum web tension for plastic films is below the level that the films is stressed to 1.5 percent of the modulus of elasticity of the film material. Examples in both the English and Metric units, as well as typical modulus of film properties in the Film Extrusion Manual — 2nd Edition, TAPPI Press, 2005, pages 313-317.

TABLE 1: Web-tension guidelines for polymer films

<table>
<thead>
<tr>
<th>FILMS</th>
<th>TENSION RANGE (Metric)</th>
<th>TENSION RANGE (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene</td>
<td>0.5 to 3.5 lb/in²</td>
<td>0.3 to 2.5 lb/in²</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>0.5 to 3.5 lb/in²</td>
<td>0.3 to 2.5 lb/in²</td>
</tr>
<tr>
<td>PET</td>
<td>0.5 to 3.5 lb/in²</td>
<td>0.3 to 2.5 lb/in²</td>
</tr>
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</tr>
</tbody>
</table>

Conversion: 1 kg/m² = 0.14 lb/in²
Cardinal Rule of Web Handling 101

Provide Isolation Of Unwinding Tension
From Various Process Tensions
From Winding Tension
For Web Tension Isolation Must Have Grip On Web!!!
Contact Type Pull Rolls

Nip Pull Rolls

Suggested Nip = 3 x Tension
Check Loaded Deflection

Rubber Covered Rolls

“S” Wrap Pull Roll
\[ \frac{T1}{T2} = f(\text{wrap, coef. of friction}) \]
“S” Wrap Will Not Isolated Tension Waves
Suction Rolls

+ Used for tension isolation when you can’t contact one side of the substrate
- Deckles for width changes
- Vacuum blower (noisy) - locate remote
Tension Rollers For Proper Web Tension Control

Highly Extensible Webs
- Draw Control w/ Transducer Operator Feedback

Normal Webs
- Unwinds - Dancer Control
- Processes - Transducer Control
- Winders - Transducer Control unless Roll Changer has significant Web Length Changes. Then must use Dancer

DANCER SYSTEM MUST BE PROPERLY DESIGNED
Z-BAR DANCER ROLL

- Center Position Control System
- Low friction, pneumatic actuated/ loading
- Roll’s Weight taken through pivots
- Hysteresis free
- Inertia compensated
- Best for Unwinds for Soft Tension Control
TRANSDUCER ROLL supported on LOAD CELLS

Best for Winder tension control
+ Most responsive for drive trimming
+ Direct readout of tension
+ Good for high speed operation

Precision roll balance for best accuracy
Web Spreading Rollers

Web Spreader Roll’s Purposes:

*To Prevent Wrinkles*

*To Separate Webs*

**CONVERTER’S CHALLENGE**

*Provide the Best Spreader for the Application And Keep Spreader Properly Adjusted*
Common Types Of Spreaders:
Listed from least to most powerful spreading action

- Reverse Crown Rollers
- FlexSpreader Rollers
- Herringbone Grooving (Al. Foil)
- Single Bowed Spreader Roll
- Dual Bowed Roll Arrangement
- Expanding Surface Spreader Roll
Reverse Crown Spreaders

- A roll that has a diameter at the ends slightly larger than in the center. The surface speed is greater at the ends than the center. The surface speed difference causes an ingoing web tension distribution that is shaped similar to the speed profile.
- Too Much Crown- Roll becomes a Web Buncher-upper!
- Most Effective on Extensible Materials
Reverse Crown Spreaders -

Please refer to Conference CD

• Application
  - Wrinkle Removal
  - Most Effective on Extensible Materials
  - Web Wrap should be Greater Than 60 Degrees
  - Web Entry Span should be 1.5x Web Width Min.
  - Suggested Dia. Difference .3-.5% of Roll Dia.
  - Poor Man’s R.C.S. is Tape on Ends of Idler Roll

• Pros
  - Least Expensive Type of Web Spreader
  - Easily Retrofitted to Operation

• Cons
  - No Running Adjustments of Spreading
  - Spreading Action is Very Product Dependant
A Flex Spreader is a roller that has a spiral grooving cut into a soft rubber covering. The grooving starts at the center & is cut at an angle so that the web tension deflects the lands outwards, carrying the web with them to provide the spreading action. The amount of spreading is a function of rubber cover hardness and Web Tension.
Flex Spreader Design

Spiral Points in Web Direction
Most Effective on Non-Extensible Materials
Flex Spreader Roll - Please refer to Conference CD

• Application:
  - Wrinkle Removal
  - Pre-wind Web Spreading with No Slitting
  - Pre-slit Web Spreading with Slitting
  - Most Effective on Non-Extensible Materials
  - Web Wrap Should be 90 Degrees or Greater

• Pros - Relatively Low Cost, Easily Retrofitted and Operated
  - Self Compensates for Tight and Loose Areas Across Web for More Uniform Cross Machine Web Tension
  - Grooving Eliminates Slippage Due to Air Entrapment

• Cons - Needs Web Tension to Provide Spreading Action
  - Limited Control of Spreading Flexibility
Aluminum Foil Spreading

Herringbone Spreader Rolls

- Outward groove machined into shell
- Roll is directional
- Works well on foil web paths
- Keep to less than 90 degrees wrap for foil
Bowed Spreader Roll

A roll with a fixed or variable curved axle supporting segmented, bearing mounted metal sleeves. Sleeves are typically covered w/ a flexible soft rubber covering. High wear applications - eliminate the cover and the metal sleeves are traction coated.
Bowed Spreader Roll - Web Behavior

Real Web

Ideal Web
Bowed Spreader

Web Path

IMPORTANT FACTORS:
- Web Length of Entry Span wants to be as long as possible to Minimize required Bow. Length of Exit Span short as possible
- Wrap Angle to be 45-180 degrees to max. traction & Minimize required Bow. (Old thinking was 15-30 degrees not true today!)
- Bow Direction to be set at 90 degrees to Bisector of Wrap Angle in the Direction of the Web Travel
Bowed Spreader Roll

Amount Of Spreading

Function of:

• Amount of Bow
• Amount of Wrap
• Amount of Web Tension
Bowed Spreader Roll - Please refer to Conference CD

Application:
- Wrinkle Removal and/or Slit Web Separation
- Can be used on both extensible and non-extensible mat’ls.
- VentAir grooving reduces slippage from air entrainment
- Lead-in web span to be as long as possible to minimize required amount of bow

• **PROS**
  - Can be used on processes having a wide range of mat’ls.
  - Can be adjusted to tighten center or ends of web
  - Readout of amount of bow available

• **CONS**
  - More complex and costly than other spreaders
  - Needs to be driven on light tension applications
  - Bow position and amount of bow on variable bow rollers may be misadjusted by the operators
  - Bearings are not able to be relubricated and diff. to replace

Web slitting applications usually limited to 4 rolls or less
Dual Bowed Roll Spreading

Schematic Courtesy of Spencer Johnston
Bows are parallel with the bows pointing 90 degrees to the lead-in and lead-out web paths as shown. The spreading action takes place between the two bowed rolls with no spreading effect upstream or downstream. Additional spreading flexibility can be provided by a rotatable table to vary the amount of wrap on the rolls.
Dual Bowed Roll Spreading

Rotatable Spreader Table

Schematic Courtesy of Spencer Johnston
Dual Bowed Spreader Roll - Please refer to Conf. CD

**Application:** Slit web separation for slitting and spreading multiple rolls (*usually 5 or more*)

- Can be used for a wide range of material and slitting variations
- Parallel lead-in and lead-out web leads and sufficient distance between rollers for web separation are critical.
- 1\(^{\text{st}}\) and 2\(^{\text{nd}}\) rolls will most likely have different amounts of bow due to deflection from tension vector.
- Spreading action function of amount of wrap, bow and web tension
Expanding Surface Spreader

A powerful spreading device that uses a series of rubber cords that stretch as the roll rotates. The amount of spreading is determined by the angle of the expansion plates. A continuous rubber sleeve helps to prevent marking. Because of the constant expansion / contraction, application is for slower speeds.
Expanding Surface rolls – Continuous Rubber Sleeve Type

Illustrations courtesy of Converter Accessory Corp.
Spreading Applications Tech Tip – Email Address.

How to Get the Most From Your Web Spreader

Almost all web processing systems require web spreading before critical components to remove wrinkles or for slit web separations. Unfortunately, many of the spreading devices are misapplied or not properly adjusted. This results in not getting the web spreading action desired and, in some cases, the spreaders become wrinkle generators.

This Tech Tip will discuss the various types of spreaders commonly used in the web converting industries, gives a description of the spreading mechanism, application information and lists the Pros and Cons for using this type of spreading device. We hope that you will find this information helpful in overcoming your web spreading challenges.

Reverse Crown Spreader

Description
A conventional roll, normally an idler but may be driven, that has a diameter at the ends slightly larger than the diameter in the center of the roll. Since the roll has a constant rpm, the surface speed is greater at the ends than the center. The surface speed difference causes an incoming web tension distribution that is shaped similar to the speed profile. The roll’s spreading action is a function of this web tension profile difference. It is important that this roll has a good traction surface to achieve the spreading action.

Application
• Wrinkle removal
• Most effective on extensible materials
• Web wrap should be greater than 90°
• Poor man’s reverse crown roll is tape on ends of roll at edges of web
Web Edge Guiding Systems

Needed on almost every web processing line to:

• Compensate for dished or telescoping rolls on unwind.

• Guide webs into critical processes such as printing, laminating or corrugation operations

• Guide webs after long web leading such as out of a drying on a coating operation.

• Guide Webs into a winding operation
Web Edge Guiding Systems

Can also be used to provide web oscillation to help randomize web profile defects before slitting and winding webs.
Keys to Success for Edge Guiding & Oscillation Systems

- Guiding System located close to where accurate web position is required.
- Designed to accommodate max. displacement required.
- Steering Guides require long lead-in web span.
- Proper edge sensor type.
- Sensor located close to shifting roll.
- Shifting roll requires traction surface.
Unwind Sidelay, Edge Guiding & Oscillation Systems

Choice of:

- Unwind mounted on sidelay base and whole unwind is shifted to guide web into process.
- Offset Pivot Guide (two roll displacement guide) positions web after it is unwound into the process.
Unwind Guiding Systems

- Sensor Fixed to Floor
- Lead-in roll fixed to Unwind
or Offset Pivot Guide (OPG)

- Positions web after it is unwound
- Web leads must be parallel
Unwind Guiding Comparison

• OPG
  + Less Expensive,
  + Unwind loading (fixed base)
  + More Responsive (less mass)

Unwind Sidelay Base - More Costly –
  + Preferred as can handle greater offsets without high web stresses, uses less MD space & easier web threading.
Intermediate Guiding

- Offset Pivot Guide (OPG)
- Camber Roller Guide (90° steering type guide)

Used for long leads into edge sensitive processes and on exit span on flotation dryers. Entry span of 3 times web width good *Rule of Thumb*
Camber Roller Guide

(90º steering type guide)

- Used on Exit of Air Flotation Dryer
- Good application if only 1 side of web can be contacted
Web Chasing Guiding Systems

Examples:

- Critical Lamination Process
- Applying a Glue Line a specific distance from the edge or line.
Winder Guiding Systems
(Guides the Winder to the web)

Sensor Fixed to Winder Lead-in
roll fixed to Floor
Winder Guiding Systems

• Used for winding straight sided rolls without edge trimming.

• Used for winder oscillation to randomize gauge bands when edge slitting is incorporated into winder frame.
Winder Guiding Systems Requirements for Success

- Rigid mounting of sensor
- Sensor close to roll fixed to floor
- Ensure that roll unloading system can accommodate guiding
Guidelines for Rolls Used in Web Handling
Article Features in:
AIMCAL’s Converting Quarterly
Issue 2012, Quarter 3

Questions
???

CONVERTING CUSTOMER IDEAS INTO SUCCESSFUL PRODUCTS
Guidelines for Rolls Used in Web Handling

Thank You!

Please contact Duane Smith at smithd@bc-egan.com