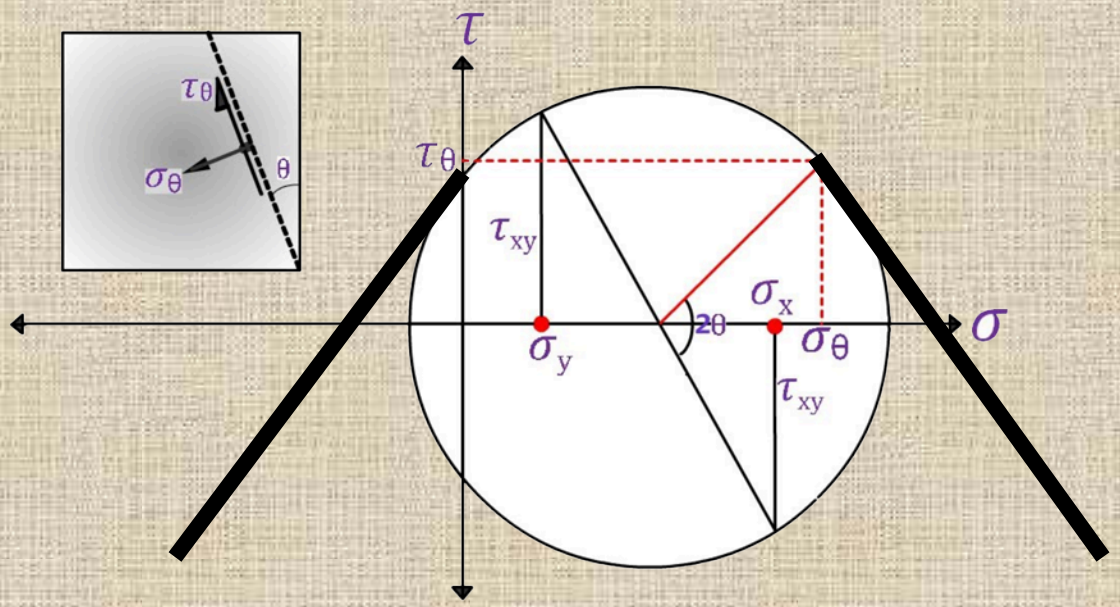
Web 101.84SM – Combined Stresses of Webs Going Over Rollers



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Elementals

- Tension Variation - *Time*
  - imperfect drives
- Tension Variation - *MD*
  - Idler roller etc bearing drag
  - Idler roller etc inertia
- Tension Variation – *CD*
  - In-plane roller misalignment
- Baggy Webs – wrt *CD*

<u>THICK WEBS ONLY:</u>

Tension varies through the *thickness*

- Bend Radius
  - Wrap over rollers
- Curl
  - Residual stress

Simple and Safe

- (But not *over*-simplified to *only* 1 stress source)

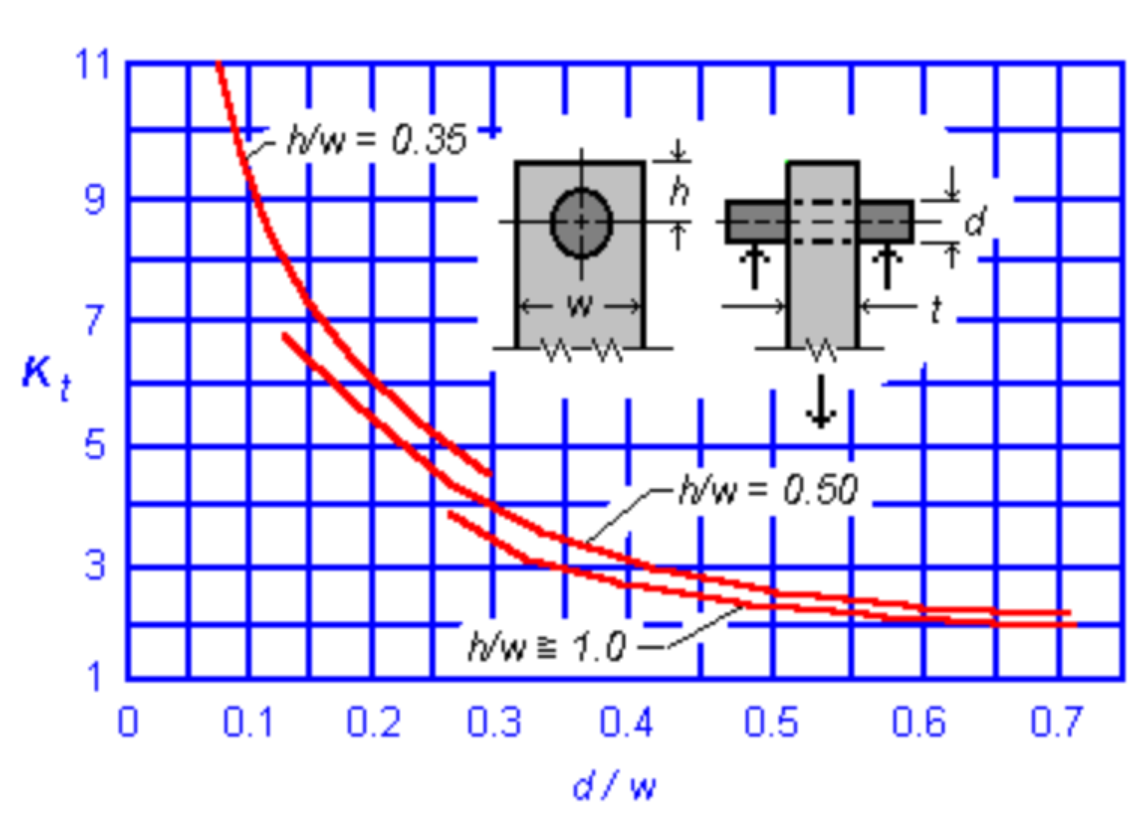
- All major sources in **simple** one line equation
- Most variables **simple** to obtain
- Sources will be treated as **Stress Multipliers**
  - F_{TDE} etc

- Overall **Safety Factor** will be calculated

- CSR by AbbottApp makes this calculation simple

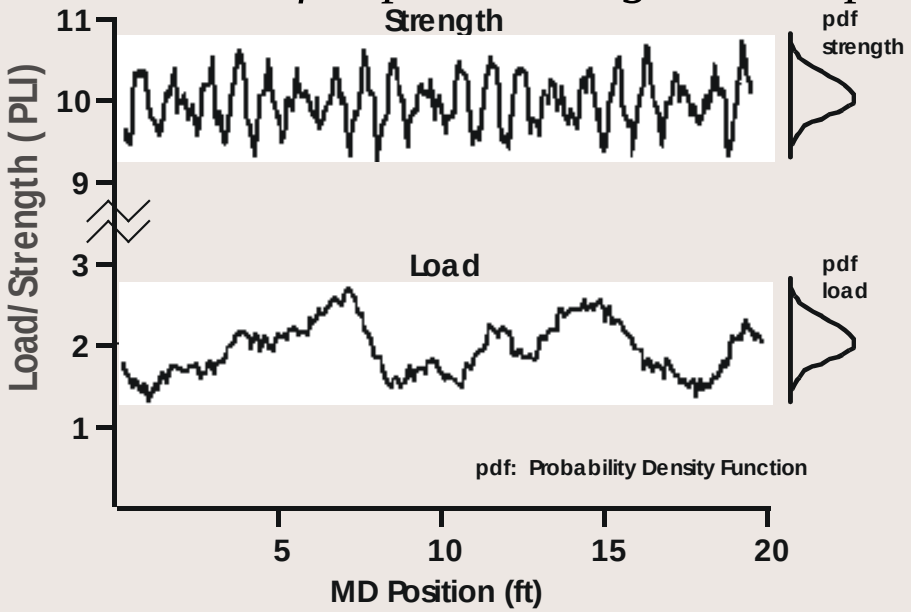
Stress Multiplier Model

- Tension on a specimen with a central hole



Tension Variations with Time

- Guidelines for average (across width) tension variations with time ($\mathbf{F_{TDE}}$) at a given roller
  - < +/- 5% of setpoint during steady state
  - < +/- 10% of setpoint during speed changes
  - < *+/- 50%? of setpoint during violent upsets*



This example
F_{TDE} = 1.1

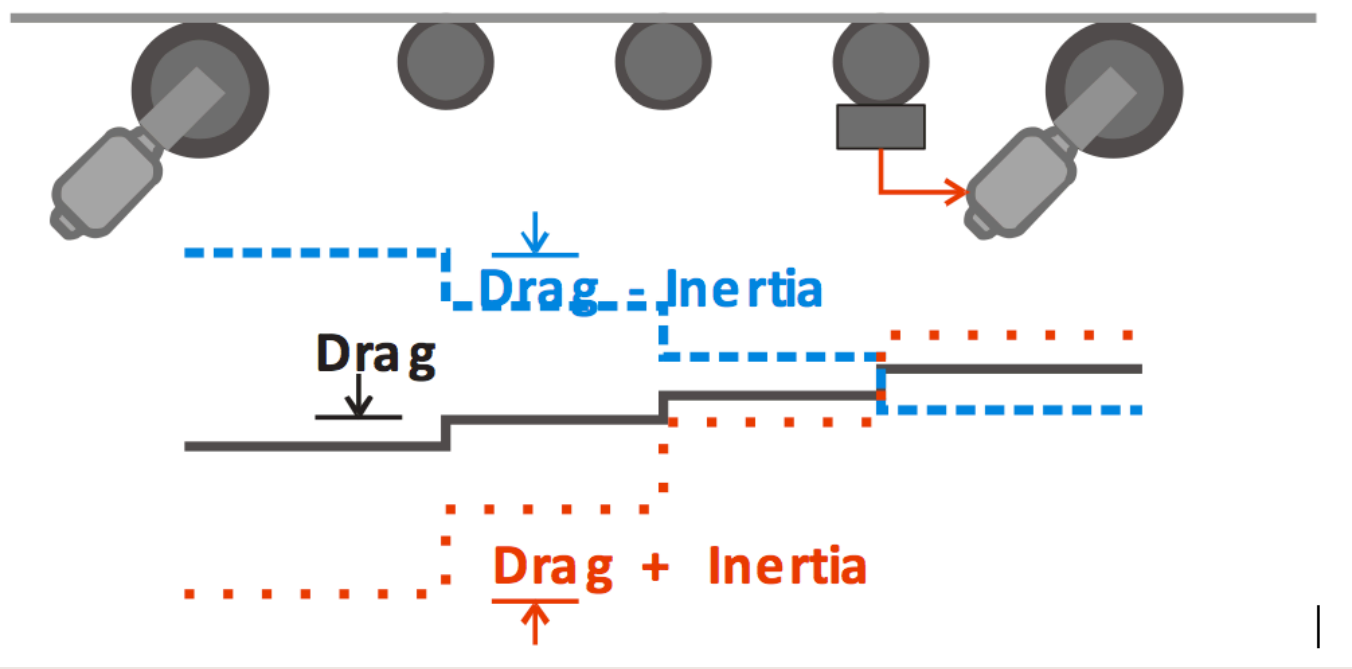
Could be written into performance spec in purchasing contract

Web Machine Buying Guide
DR Roisum
Destech & TAPPI

Tension Variations with MD

- Guidelines for average (across width) tension rise in a drive zone ($\mathbf{F_{TDM}}$)
  < 10% of setpoint

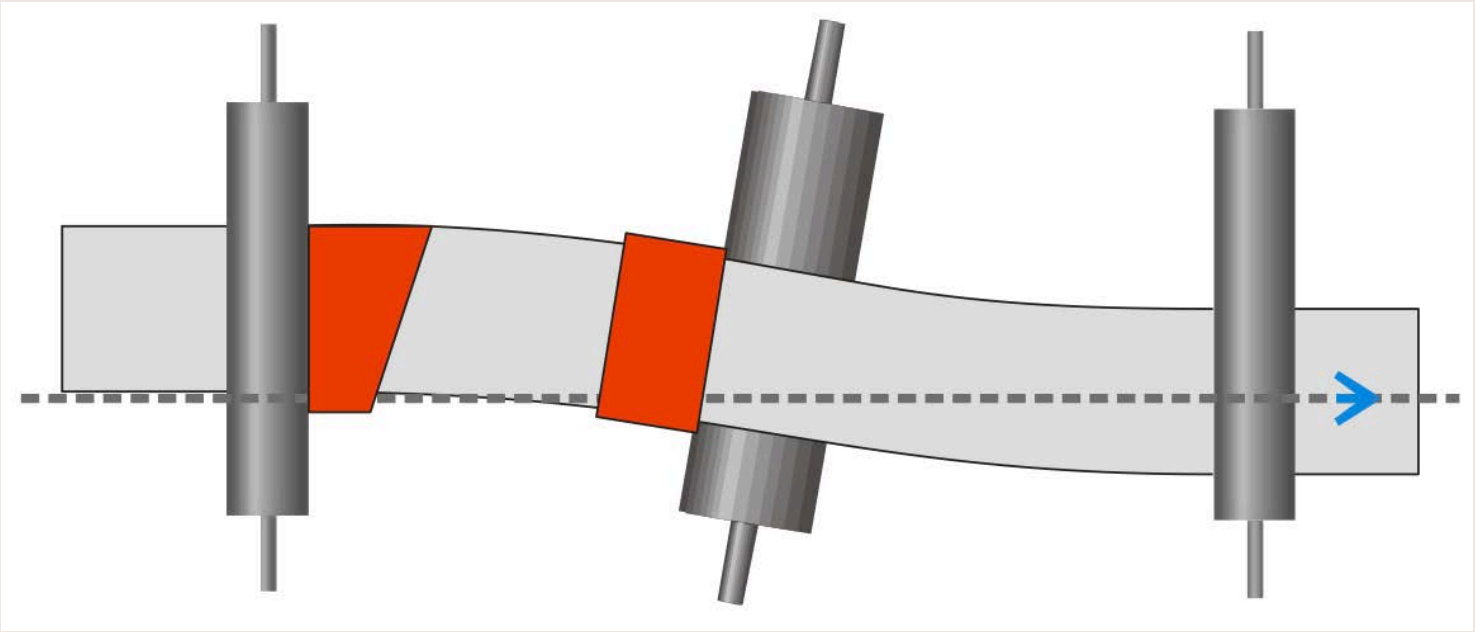
This example F_{TDM} = 1.1



Tension Variations in CD

- Guidelines for tension variations across width due to **inplane roller misalignment (F_M)**

  < slack web on inside of curve or 2 X average on outside



Slack Web Calculation

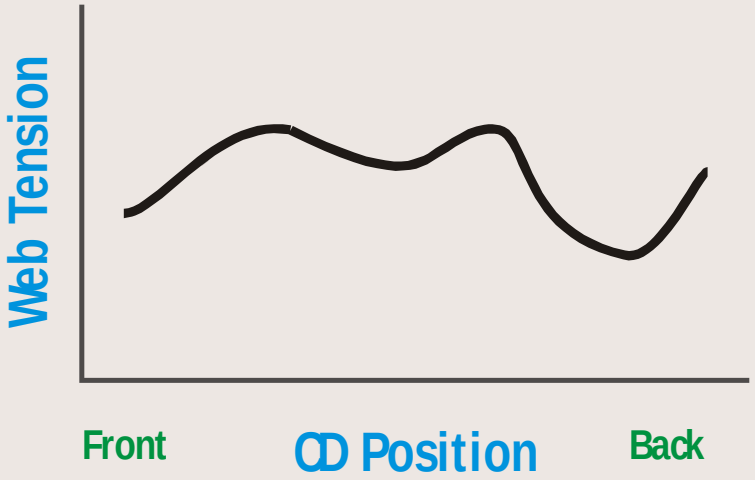
- Using guiding theory (Shelton, 1965) we can calculate the multiplication factor (w.r.t. stress riser on outside of bend) as

$$F_M = 1 + \frac{\theta_i}{\varepsilon_T \frac{L}{W}}$$

Where
θ = misalignment angle
ε_T= strain due to tension
L = length of span
W = width of span

Baggy Webs

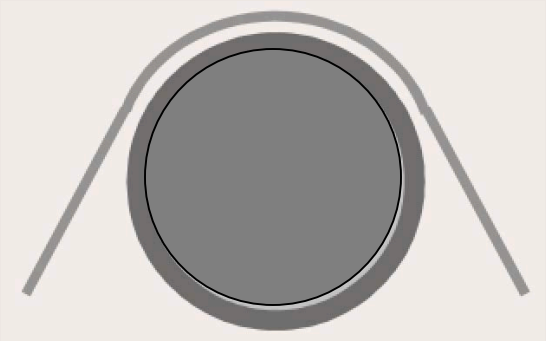
- We will give the stress multiplier due to bagginess as $\mathbf{F_B}$



Bend Radius On Rollers

- Only a concern for thick webs
- We calculate strain multiplier as

$$\varepsilon_{RBR} = \frac{half\ thickness}{radius\ of\ curvature} = \frac{t}{D}$$



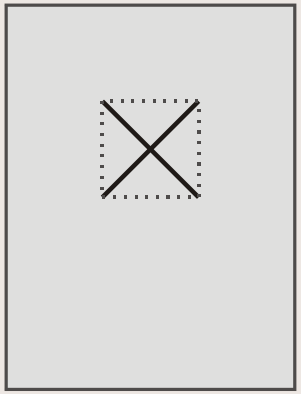
Curl

- Only a concern for thick webs
- We calculate strain multiplier from measured curl radius as

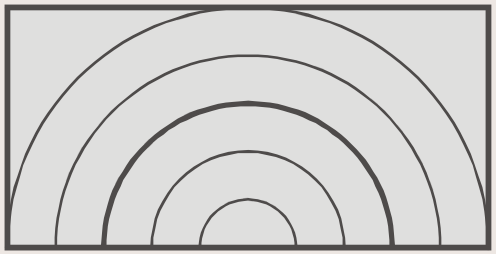
$$\varepsilon_C = \frac{t}{2r_C}$$

Curl **Measurement**

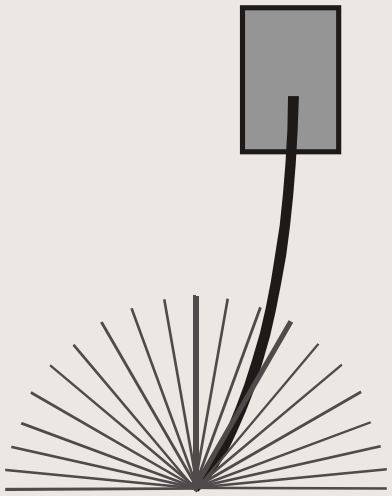
- X Cut



- Radius Template



- Hanging Angle



Swanson, Ron. *Measurement of Web Curl.* AIMCAL Web Handling Conf., Charlotte, May 7-10, 2006

Summary Safety Factor

0) Check that all components are in **MD**

1)Check that all components *could* align in **space**

2)Check that all components *could* align in **time**

- Ultimate Safety Factor considering all c

$$SF = \frac{\sigma_Y}{E_1 F_B F_M F_{TDE} F_{TDM} [\varepsilon_T + \varepsilon_C + \varepsilon_{RBR}]}$$

Applications

- First calculate a Safety Factor for a known marginal application.
- Then one could allocate a precision budget in different ways. Examples.
  - Difficult drives might demand more precise alignment in compensation
  - Baggy webs might demand more precise mechanicals and controls to not go over ‘budget’
  - While you still will not be allowed to run crappy web on a crappy machine, you will at least know what you need to change

Generalizations

Tmax Tyield	Sfmin	Industry	Major Variations / Concerns
4	3	Paper	Mild bagginess / web breaks
2	1.5	Tissue	Extreme bagginess / loss of crepe
5	2-3	Film convert	Bagginess, misalign / many
4-5	??	Yours	Your mileage may vary

Limitations & Future Work

- Slightly conservative because it assumes worst case *alignment* of contributions
- Anisotropic considerations are minor
- Linearity (because we used *superposition*):
- Contributions singly or in combination can not be so severe as to cause a *slack web*

- Still, SIB (Simple Is Best)

Questions?

Answers:

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