

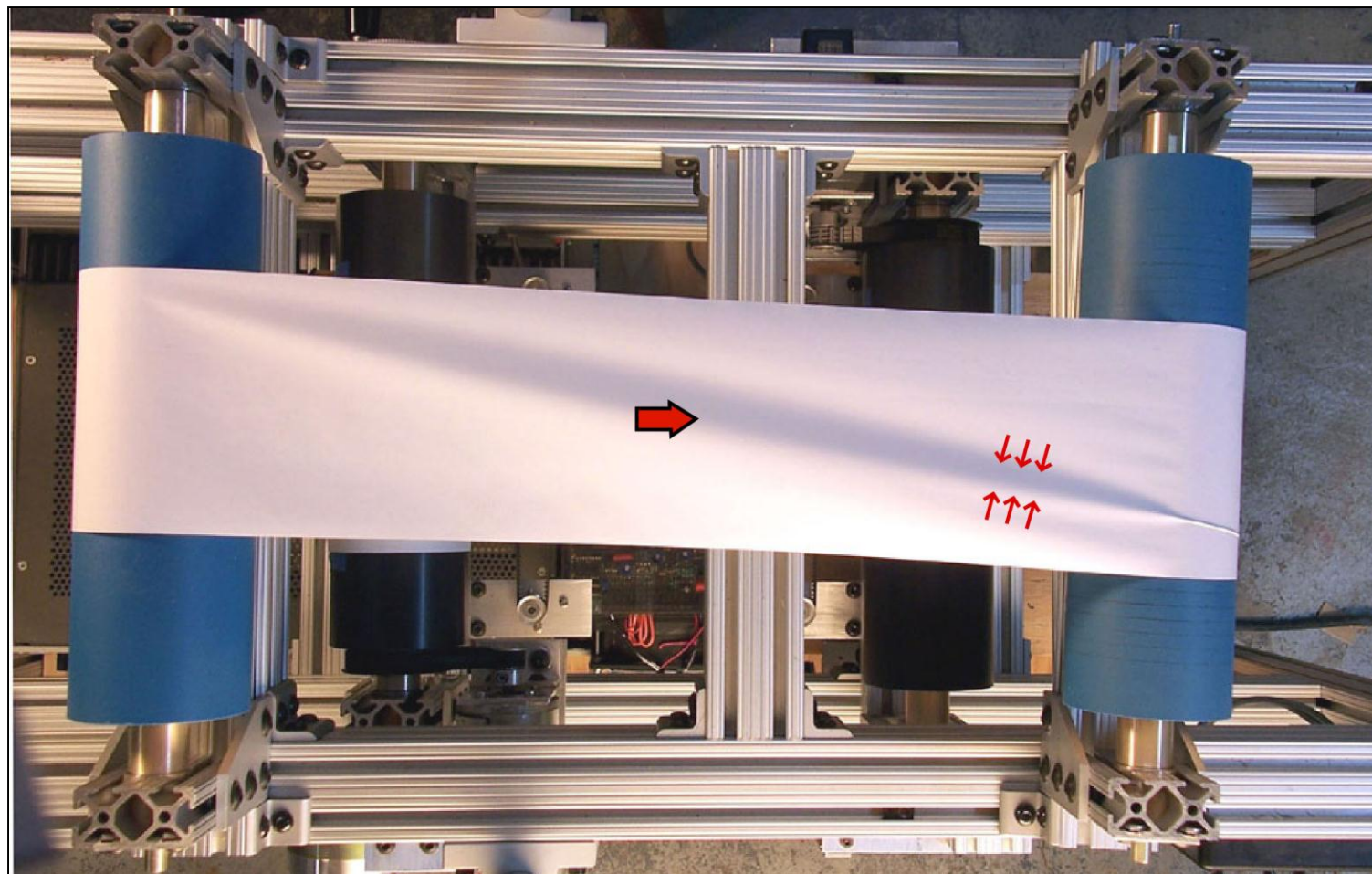
What FEA Analysis Can Tell Us About Spreaders

Jerry Brown

Essex Systems

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Compressive stress



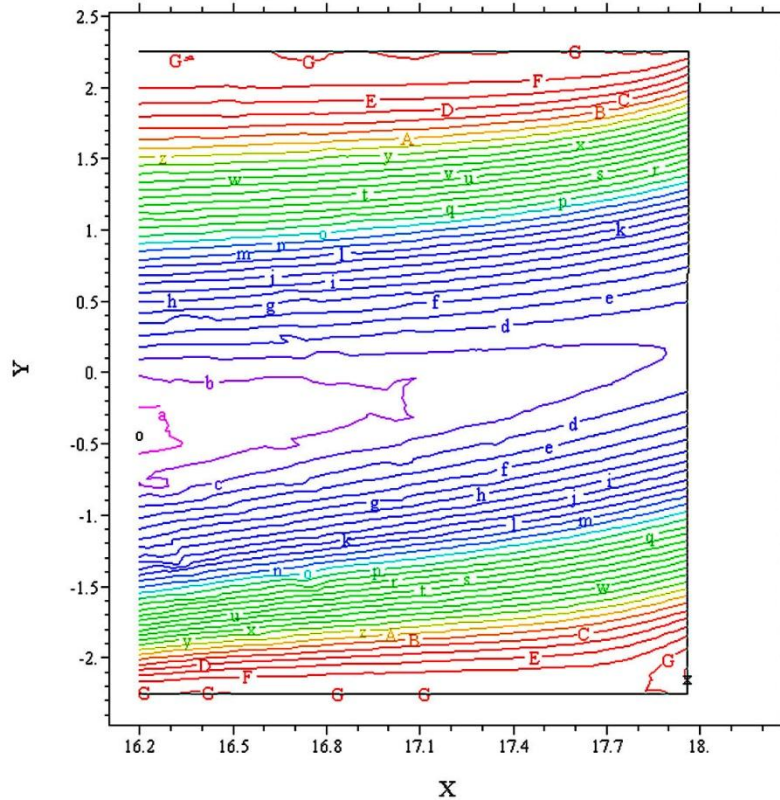
Parameters for the paper web

- Length of span = 18 inches
- Width = 4.5 inches
- Thickness = 0.003 inch
- Tension = 6 Lbf
- Modulus = 500,000 psi (estimated)
- Poisson's ratio = 0.25 (estimated)
- Misalignment = 2.7 degrees

Compressive stress at a misaligned roller

Misaligned Roller Analysis Step IV

FlexPDE 5.0.21

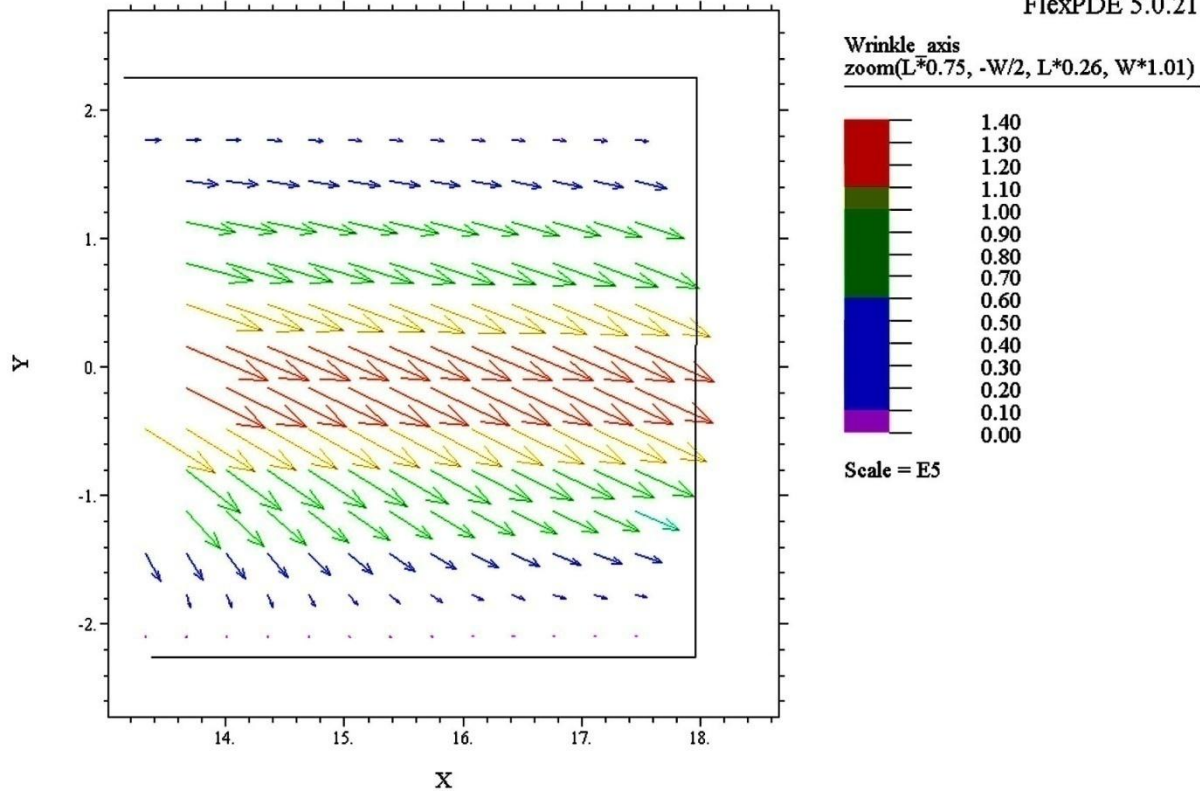


Smin		
zoom(L*0.9, -W/2, L*0.11, W*1.01)		
max	5.46	d: -145.
H:	5.00	c: -150.
G:	0.00	b: -160.
F:	-5.00	a: -155.
E:	-10.0	min
D:	-15.0	-163.
C:	-20.0	
B:	-25.0	
A:	-30.0	
z:	-35.0	
y:	-40.0	
x:	-45.0	
w:	-50.0	
v:	-55.0	
u:	-60.0	
t:	-65.0	
s:	-70.0	
r:	-75.0	
q:	-80.0	
p:	-85.0	
o:	-90.0	
n:	-95.0	
m:	-100.	
l:	-105.	
k:	-110.	
j:	-115.	
i:	-120.	
h:	-125.	
g:	-130.	
f:	-135.	
e:	-140.	

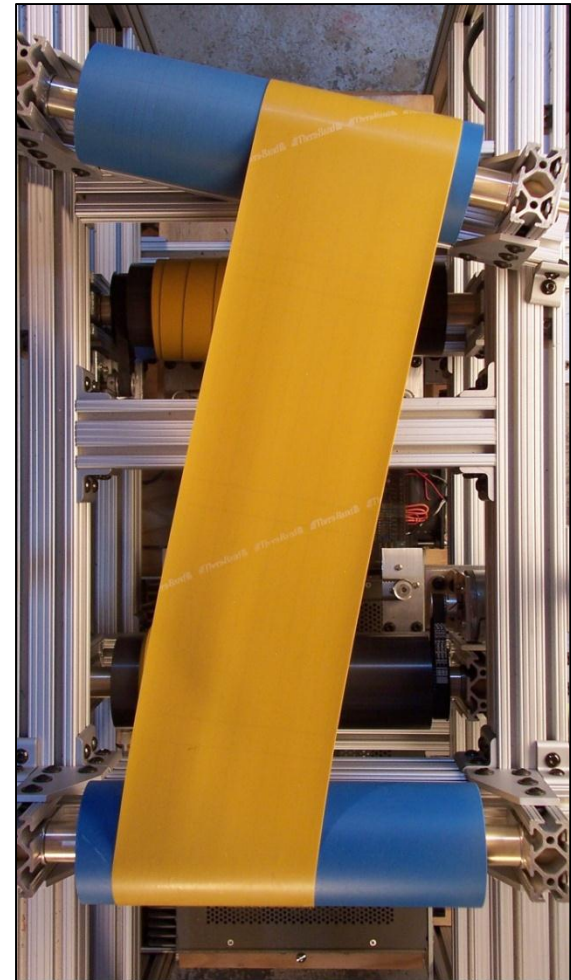
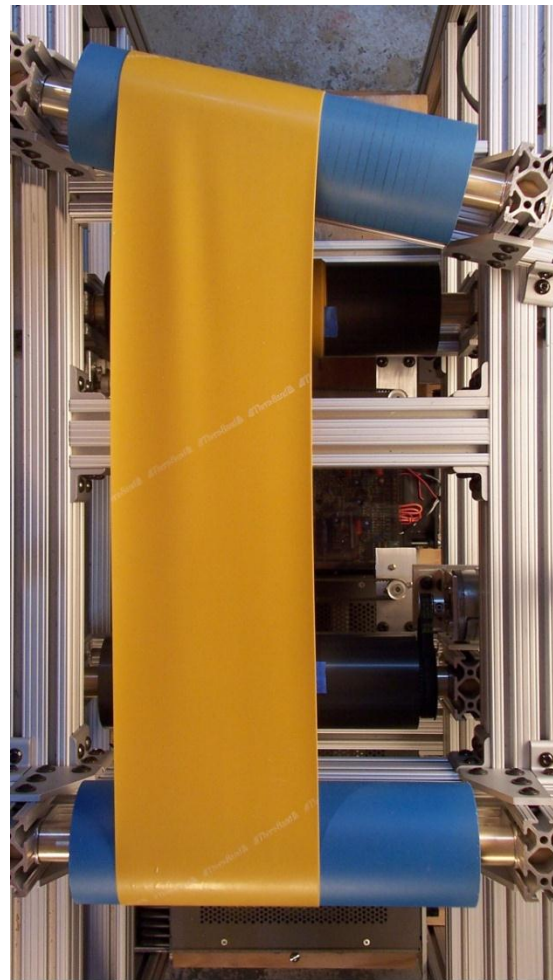
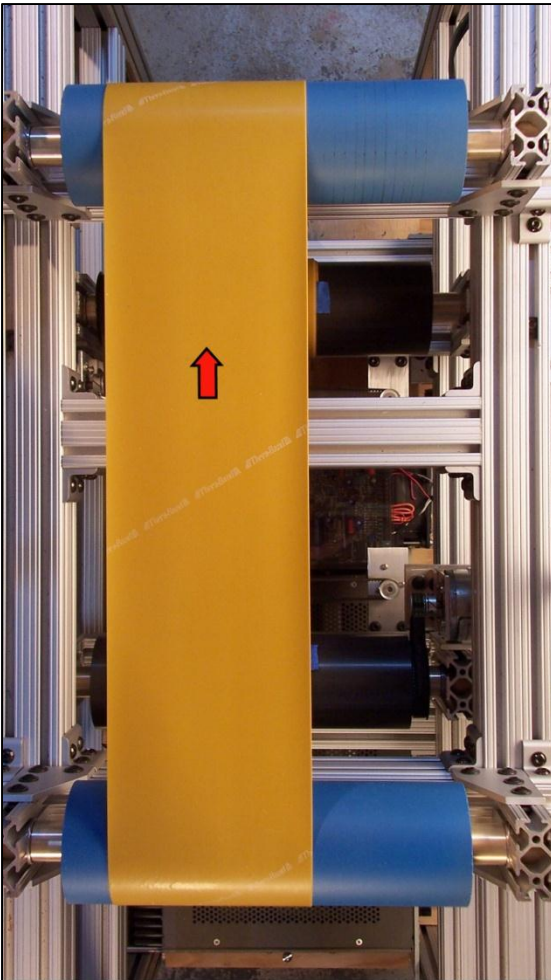
Trough direction vectors

Misaligned Roller Analysis Step IV

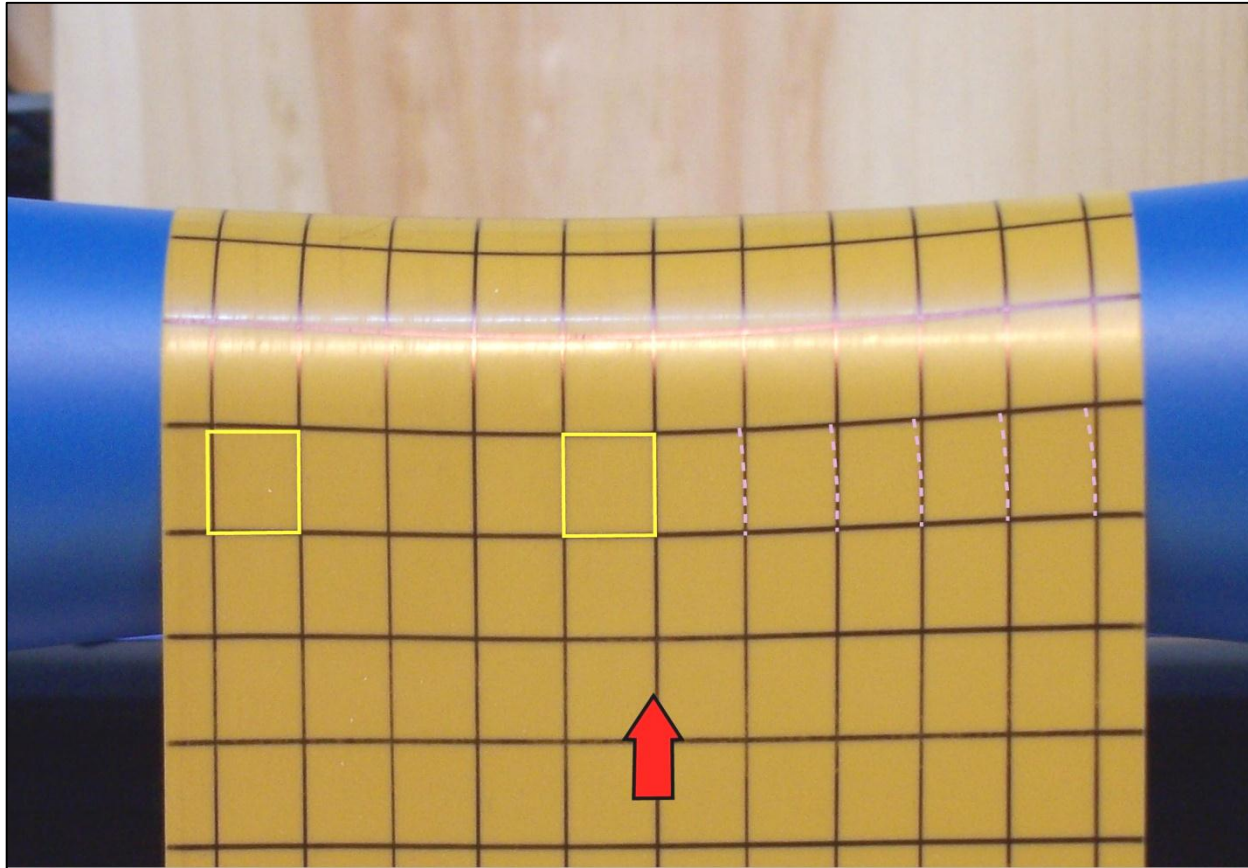
FlexPDE 5.0.21



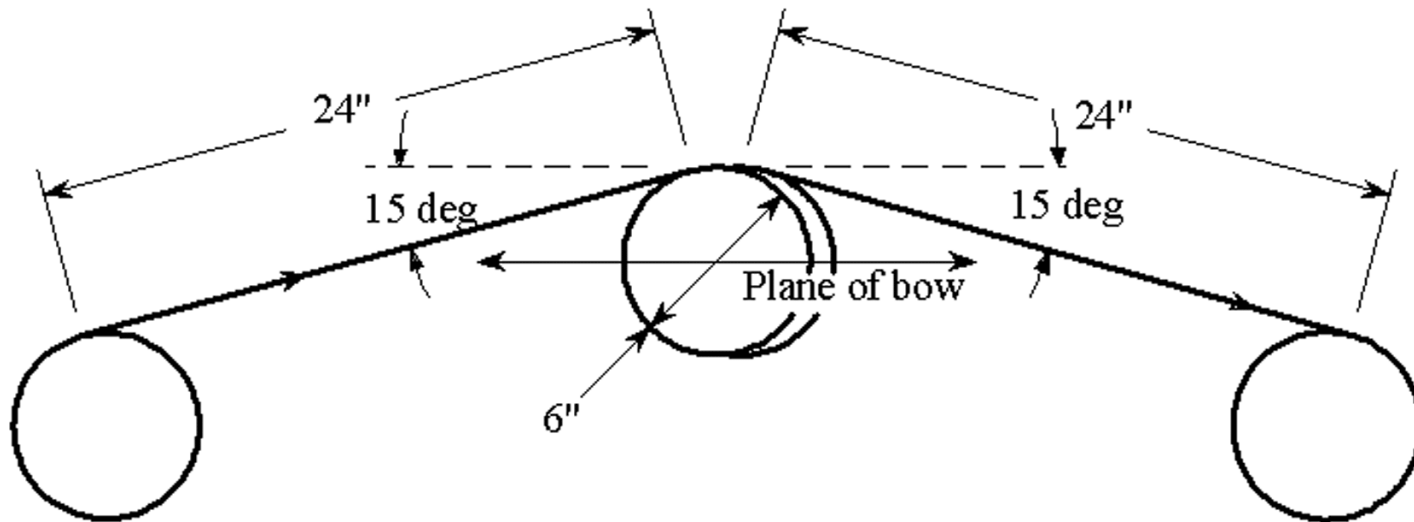
Normal entry rule



Normal strain rule



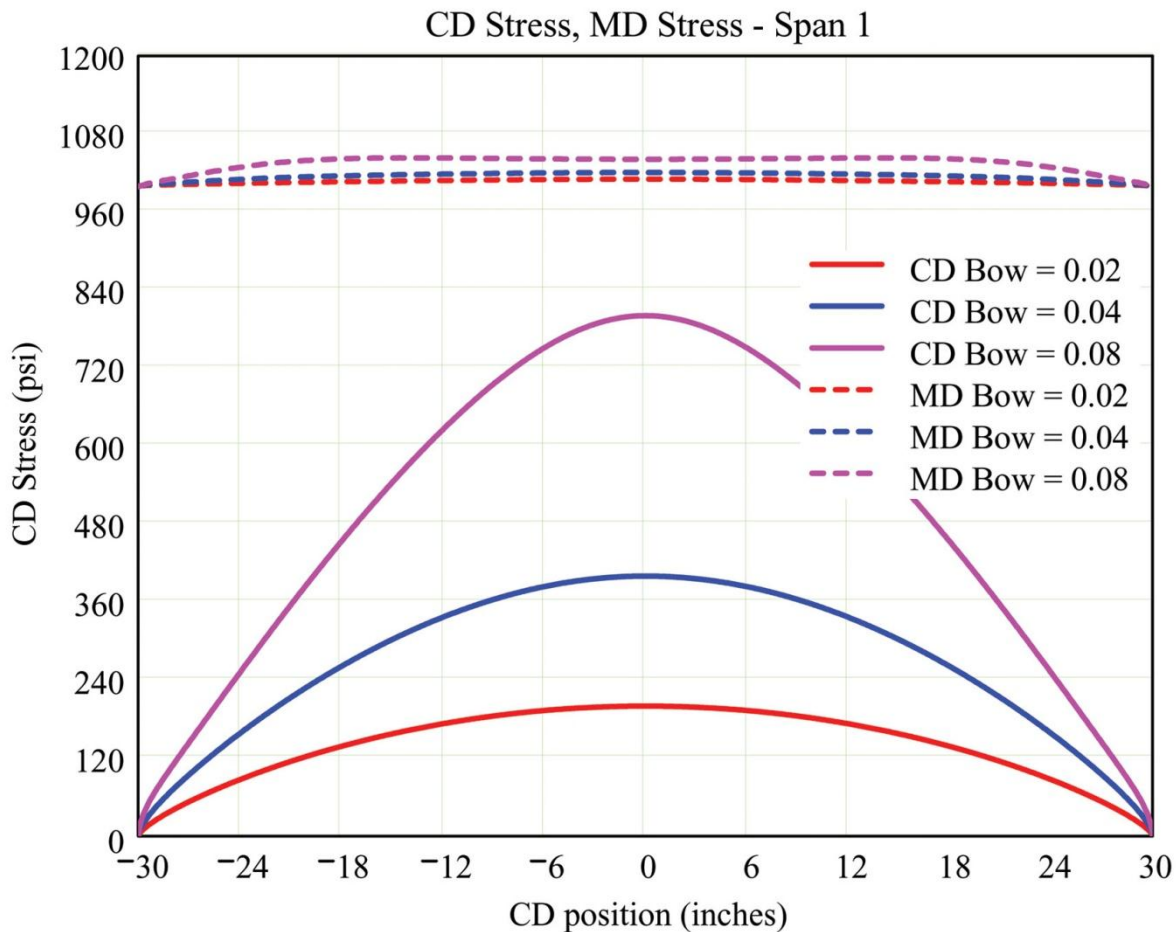
Bowed roller application



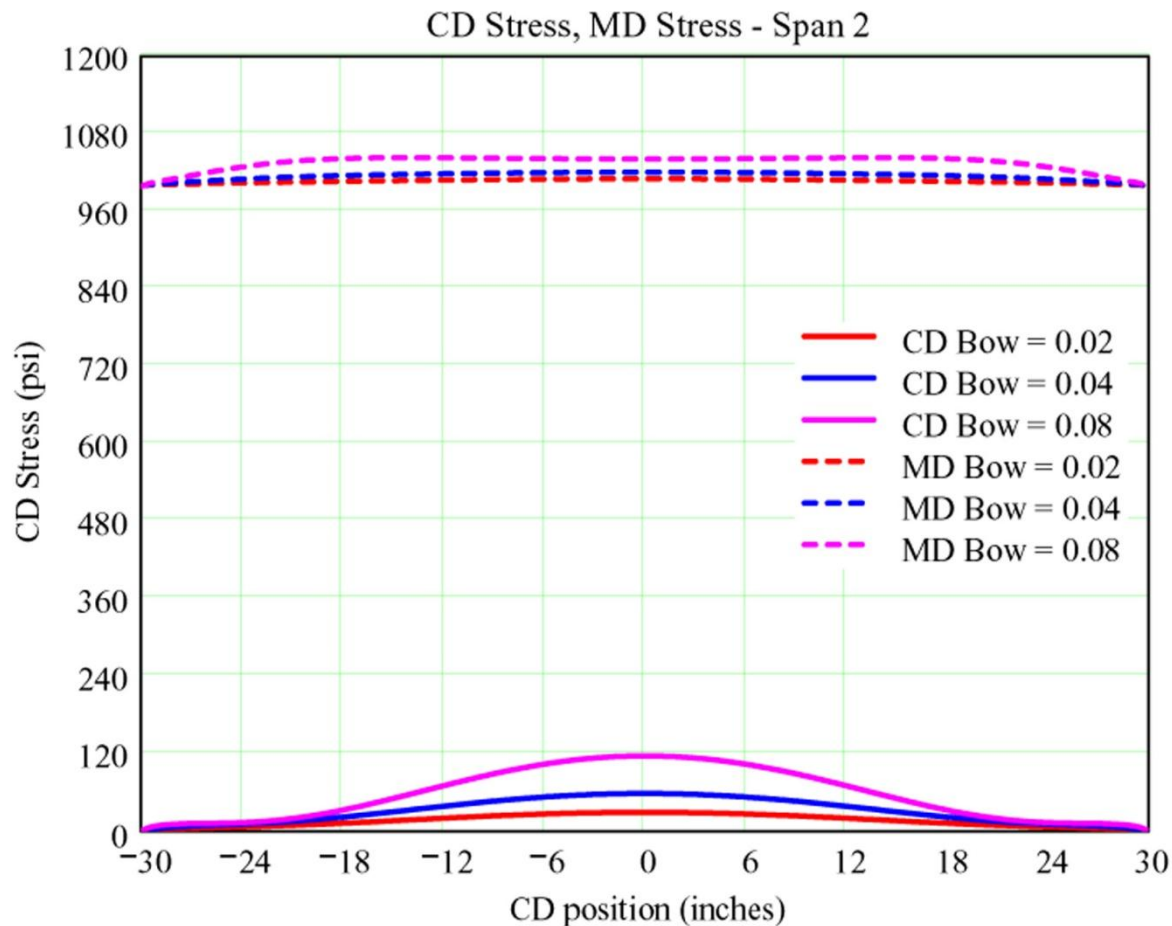
Parameters

- Width = 60 inches
- Thickness = 0.0005 inch
- Modulus = 600,000 psi
- Poisson's ratio = 0.35
- Roller length = 72 inches
- Coefficient of friction = 0.5

Stresses at entry to bowed roller



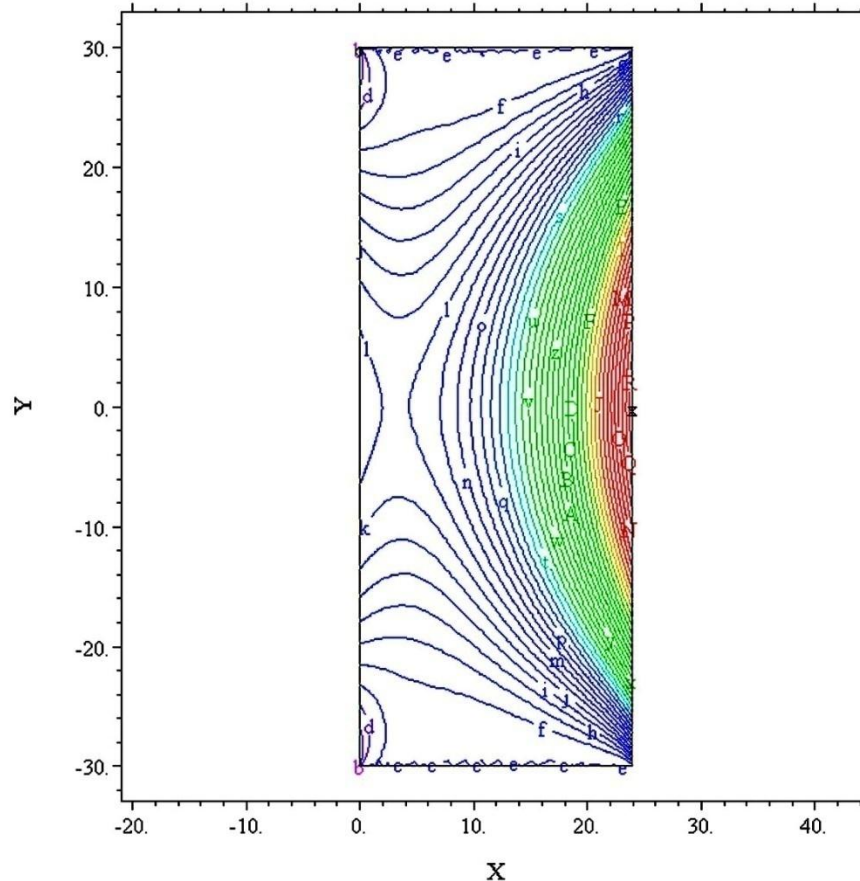
Stresses at entry to next idler



CD stress pattern in entry span

Curved axis roller

FlexPDE 5.0.21

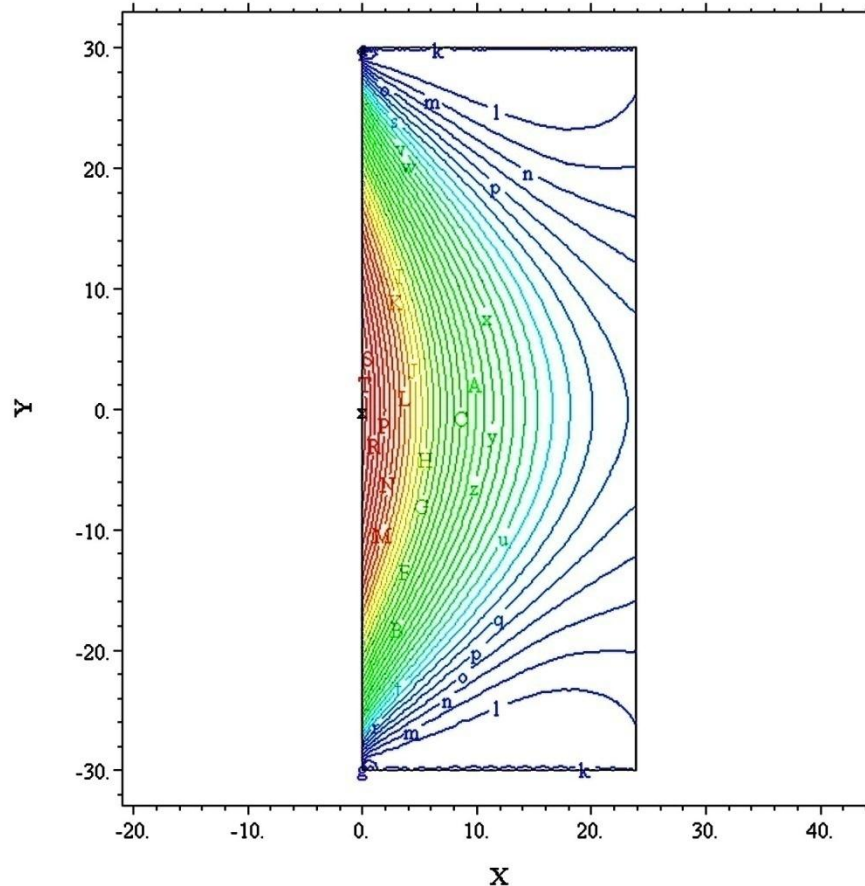


Smin

max	199.	m :	40.0
R :	195.	l :	35.0
Q :	190.	k :	30.0
P :	185.	j :	25.0
O :	180.	i :	20.0
N :	175.	h :	15.0
M :	170.	g :	10.0
L :	165.	f :	5.00
K :	160.	e :	0.00
J :	155.	d :	-5.00
I :	150.	c :	-10.0
H :	145.	b :	-15.0
G :	140.	a :	-20.0
F :	135.	min	-21.4
E :	130.		
D :	125.		
C :	120.		
B :	115.		
A :	110.		
z :	105.		
y :	100.		
x :	95.0		
w :	90.0		
v :	85.0		
u :	80.0		
t :	75.0		
s :	70.0		
r :	65.0		
q :	60.0		
p :	55.0		
o :	50.0		
n :	45.0		

CD stress pattern in exit span

Curved axis roller



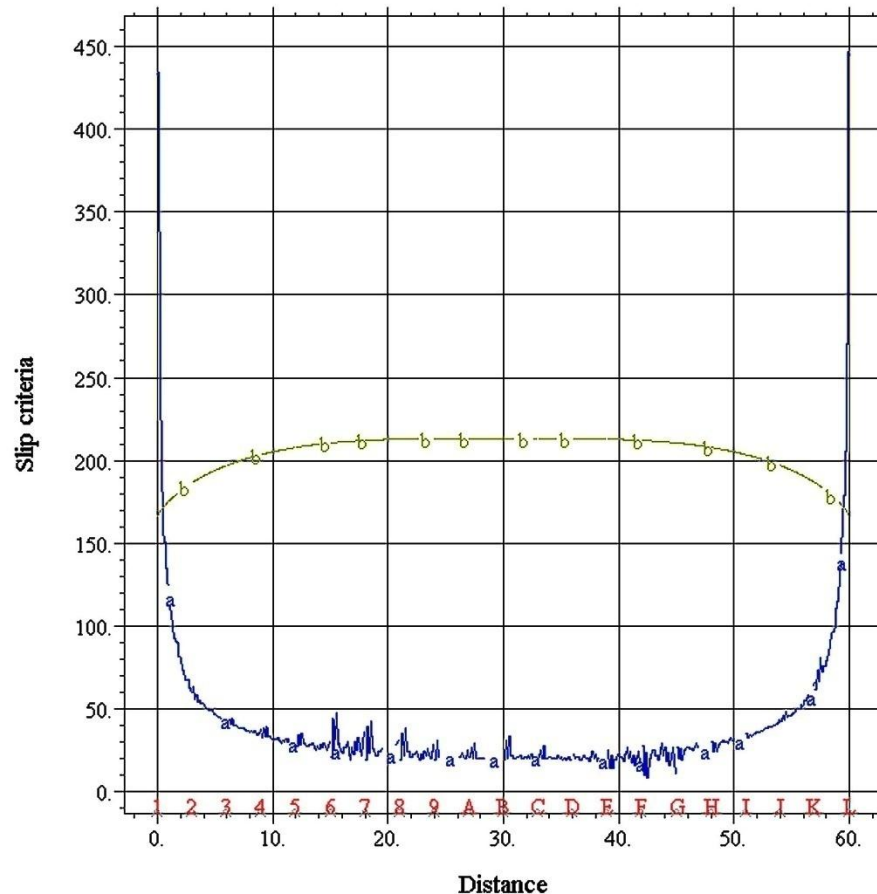
FlexPDE 5.0.21

Smin

max	178.	o :	20.0
T :	175.	n :	15.0
S :	170.	m :	10.0
R :	165.	l :	5.00
Q :	160.	k :	0.00
P :	155.	j :	-5.00
O :	150.	i :	-10.0
N :	145.	h :	-15.0
M :	140.	g :	-20.0
L :	135.	f :	-25.0
K :	130.	e :	-30.0
J :	125.	d :	-35.0
I :	120.	c :	-40.0
H :	115.	b :	-45.0
G :	110.	a :	-50.0
F :	105.	min	-51.4
E :	100.		
D :	95.0		
C :	90.0		
B :	85.0		
A :	80.0		
z :	75.0		
y :	70.0		
x :	65.0		
w :	60.0		
v :	55.0		
u :	50.0		
t :	45.0		
s :	40.0		
r :	35.0		
q :	30.0		
p :	25.0		

Traction on bowed roller

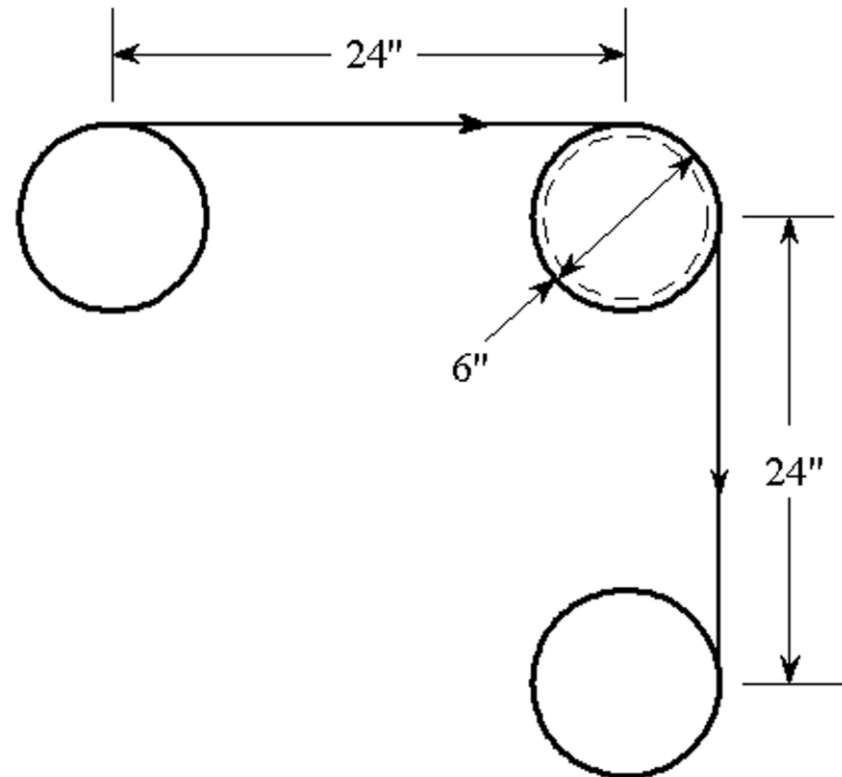
Curved axis roller



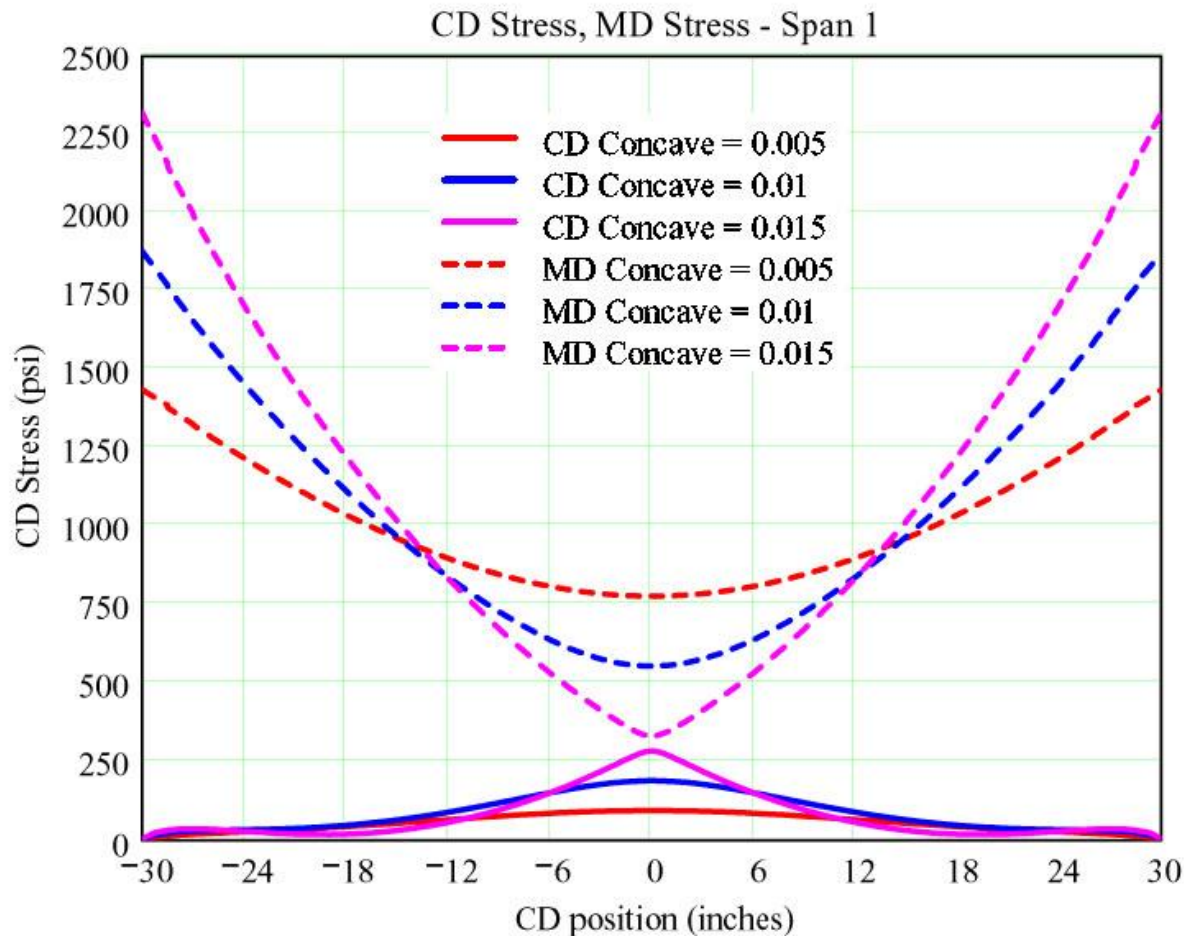
Conclusions about bowed rollers

- It doesn't take much bow to have a big effect.
- The spreading action has little effect on the MD stress profile.
- The exit span should be kept very short if spreading action is needed at the next roller.
- Bowed rollers are aggressive spreaders that can be adjusted to create excessive spreading stresses, resulting in lateral slipping.

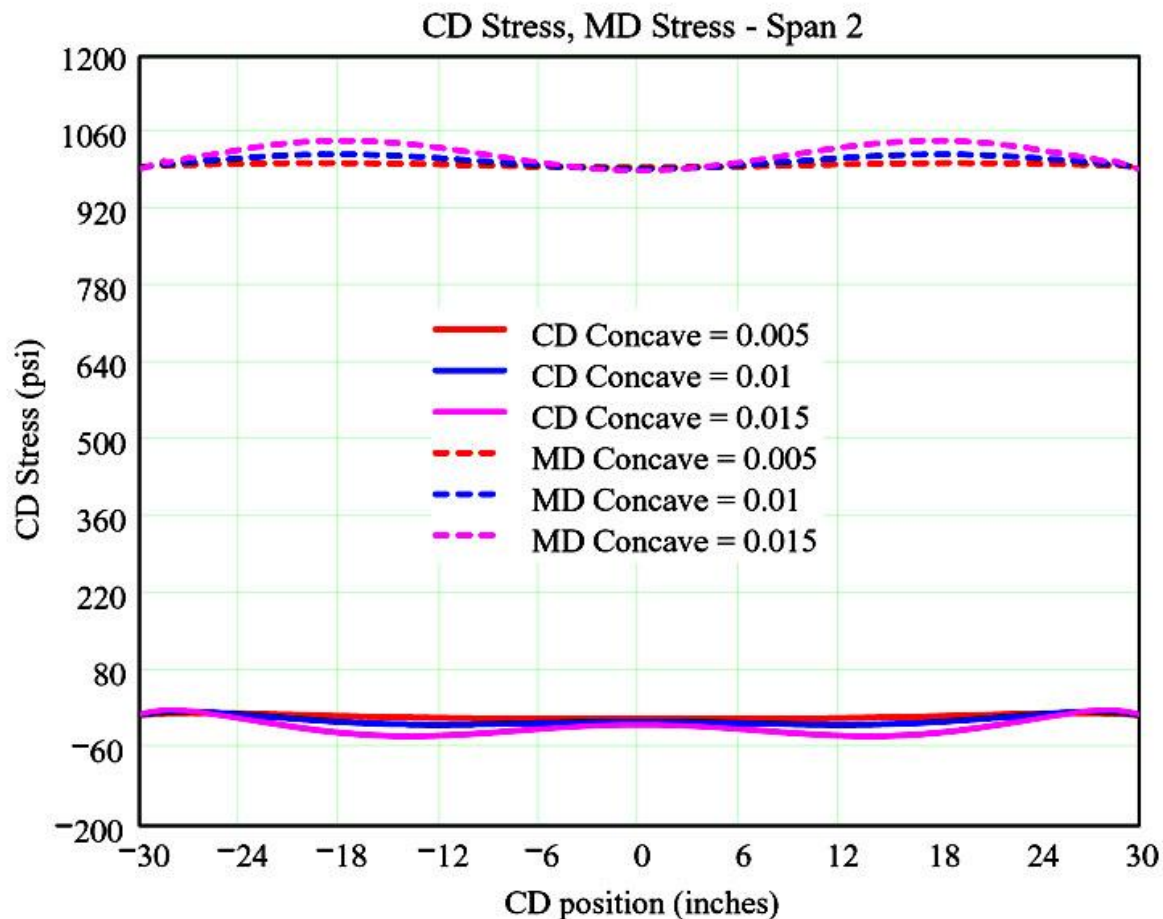
Concave roller application



Stresses at entry to concave roller



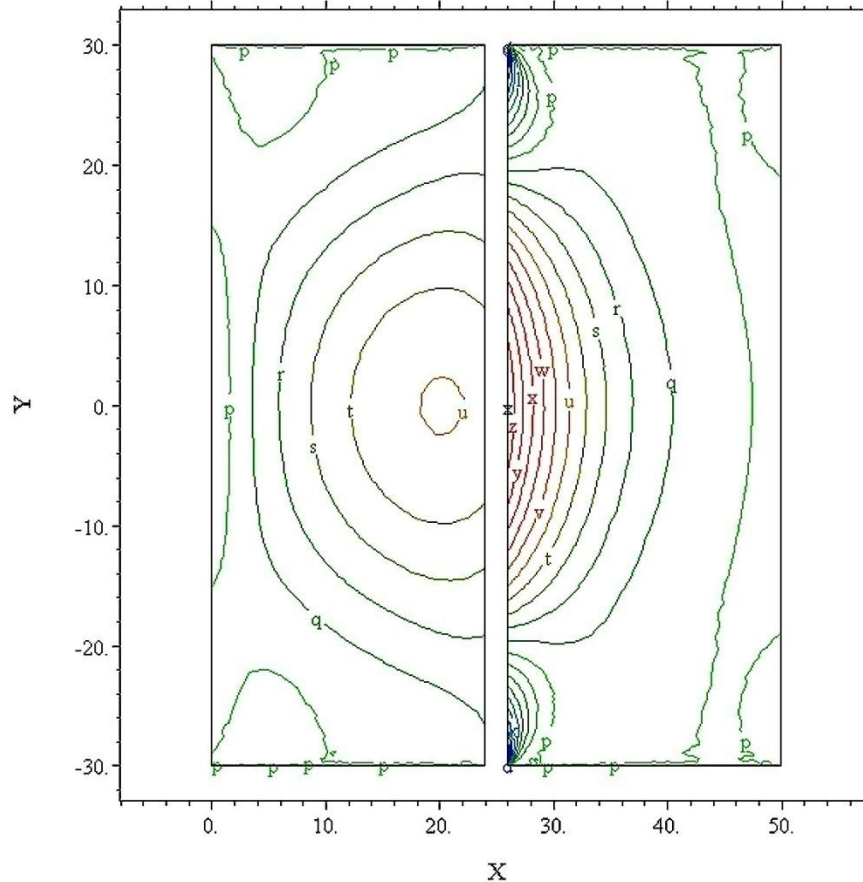
Stresses at entry to next idler



CD stress pattern in spans

Concave Roller Analysis Step IV

FlexPDE 5.0.21



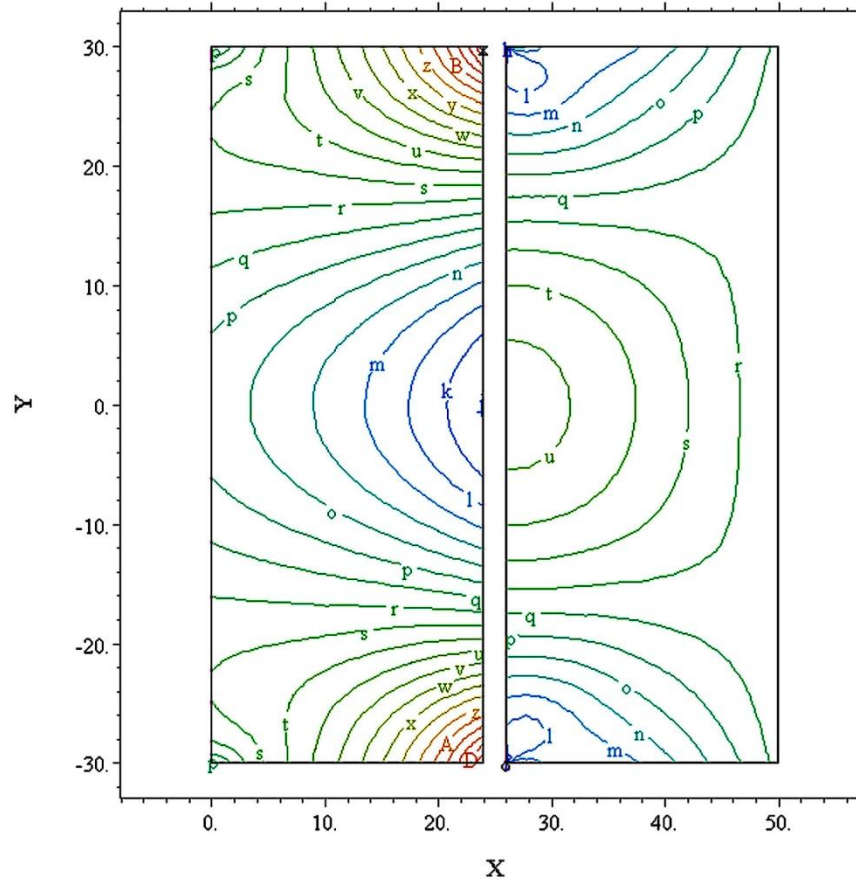
2. Principal CD stress

max	215.
z:	200.
y:	180.
x:	160.
w:	140.
v:	120.
u:	100.
t:	80.0
s:	60.0
r:	40.0
q:	20.0
p:	0.00
o:	-20.0
n:	-40.0
m:	-60.0
l:	-80.0
k:	-100.
j:	-120.
i:	-140.
h:	-160.
g:	-180.
f:	-200.
e:	-220.
d:	-240.
c:	-260.
b:	-280.
a:	-300.
min	-302.

MD stress pattern in spans

Concave Roller

FlexPDE 5.0.21

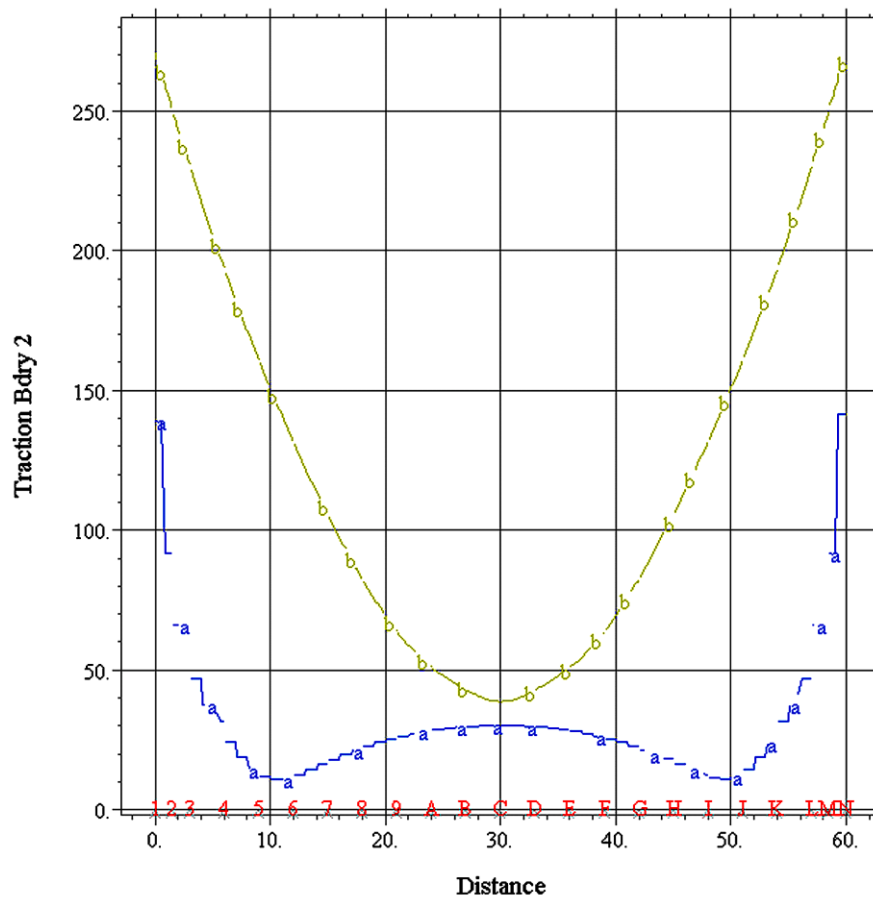


1. Principal MD stress

max	1.44	a :	0.51
F :	1.44	min	0.50
E :	1.41		
D :	1.38	Scale = E3	
C :	1.35		
B :	1.32		
A :	1.29		
z :	1.26		
y :	1.23		
x :	1.20		
w :	1.17		
v :	1.14		
u :	1.11		
t :	1.08		
s :	1.05		
r :	1.02		
q :	0.99		
p :	0.96		
o :	0.93		
n :	0.90		
m :	0.87		
l :	0.84		
k :	0.81		
j :	0.78		
i :	0.75		
h :	0.72		
g :	0.69		
f :	0.66		
e :	0.63		
d :	0.60		
c :	0.57		
b :	0.54		

Traction on concave roller

Concave Roller



Conclusions about concave rollers

- Very stiff materials such as PET require profiles that are of the same magnitude as roller tolerances.
 - For single-purpose lines, running constant width, it may be possible to optimize the profile design to get inside a narrow window of feasibility.
- This type of spreader works best on stretchy materials like polyethylene.

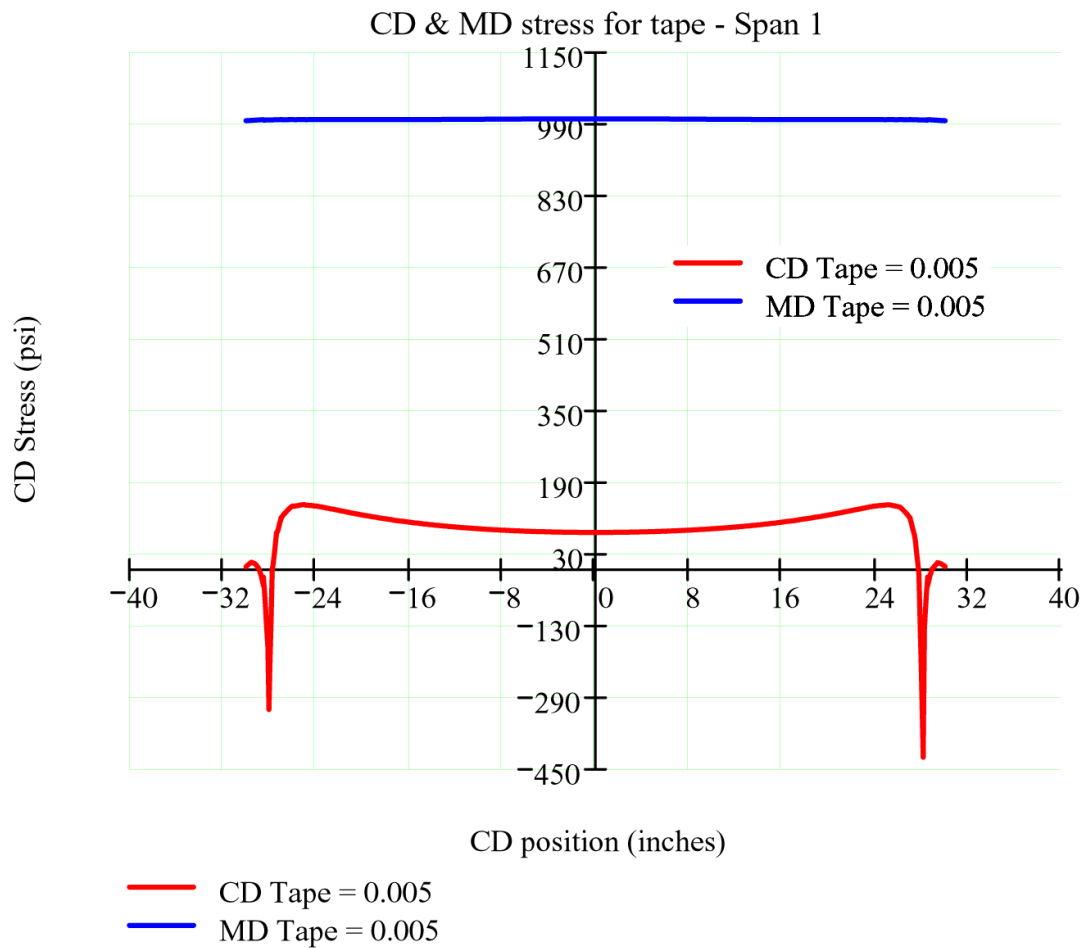
More on concave rollers

- The benefits of spreading are seen mostly at the spreader roller itself. If concern is spreading downstream, such as entry to a nip, the exit span should be kept very short.

Tape bumpers

- The next slide will illustrate the effect of using tape bumpers – a band of thin tape applied around the circumference of an idler to produce a stepped profile.
- The next slide shows the effect of a 0.005 inch step on the radius that extends for two inches under each edge of the web.
- Other parameters are the same as in the previous examples.

Tape bumpers



General conclusions

- Bowed rollers are very effective spreaders that are theoretically superior to concave rollers. It is unfortunate that they have so many mechanical drawbacks.
 - high turning torque
 - large tolerances on their diameter
 - high maintenance due to bearing wear and flexural fatigue of the covering.
 - Adjustments that open the door to mischief.

General conclusions

- Concave rollers can be very effective, low-maintenance spreaders if they are designed carefully for the application.
- It is easy to overdo spreading of both types.



QUESTIONS?

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