The Lightweight Papermachine Project
Status as of Fall 2009

For more information, go to:

http://papermachine2025.ning.com/

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The Premise

- As paper machines have become wider and faster, their mass has increased, one might say, asymptotically (more later).
- This increase in mass has been due to the machine itself, not the paper or paperboard (the entire weight of a 42# sheet of linerboard in a modern, 240” wide machine is only ~ 294 pounds from headbox to reel, or .0005 psi over the footprint of the machine). By reference, a woman’s spike heel shoe, assuming she weighs 120 pounds and is standing evenly on both feet, exerts a force of ~ 960 psi or 1,920,000 times the force exerted by the paperboard (for more, go to http://tinyurl.com/ykhlmy6).

The Promise

- Setting a goal of reducing the weight of papermachines allows all talented people to contribute in creative ways.
- If we can reduce the weight of a papermachine (in any grade) by ½, we will
  - reduce the consumption of raw materials to make the machine,
  - reduce the strength and size of the structure needed to support the machine, and
  - reduce the energy needed to operate the machine.

The Problem (a small glimpse in only one tiny area)

- Looking down a papermachine, with the cross machine direction on the horizon, we notice that the paper machine is like a bridge:

The Bill Emerson Bridge (at left), crossing the Mississippi River at Cape Girardeau, Missouri, represents the latest in cable-stay bridge design, including active seismic monitoring and, potentially, control. This is the only 4 lane bridge crossing the Mississippi between St. Louis, Missouri and Cairo, Illinois.

In fact, a river and a bridge are a good model of a press section

- Think of the river as the “machine direction” (it’s consistency is only slightly lower than that of the sheet in a press section).
- The bridge is a good model for a press roll.

2003 Bridge:

High geometry lowers weight.

Concrete in compression (its highest strength application).

Steel in tension (its highest strength application).

1929 Bridge:

Lots of steel, both in compression and tension. Low profile takes more material. Not efficient.

This location is one of the most seismically dangerous in the US (more dangerous than California) and the 2003 Bridge is state-of-the art to handle the potential vibration.

- Old papermachine press roll:

- New papermachine press roll:

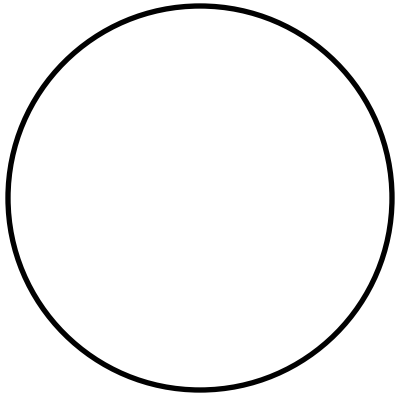
The Roll Problem

- Spanning a papermachine in the cross machine direction is a beam theory problem:

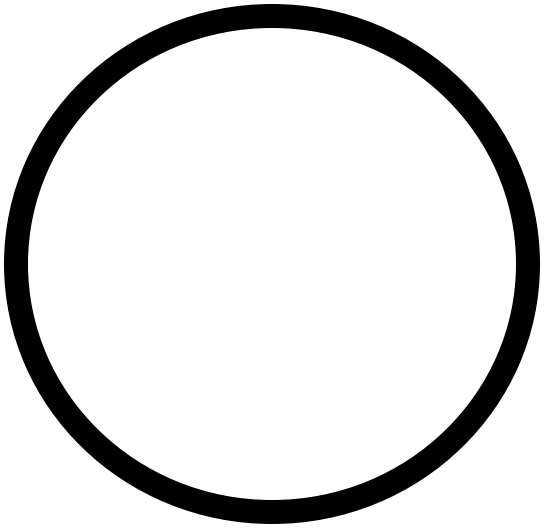
This picture was taken in New York ~ one year after the construction of the old Cape Girardeau Bridge.

Of a special type--

This beam is not static, but rotating



Representation of cross section of roll spanning small machine.

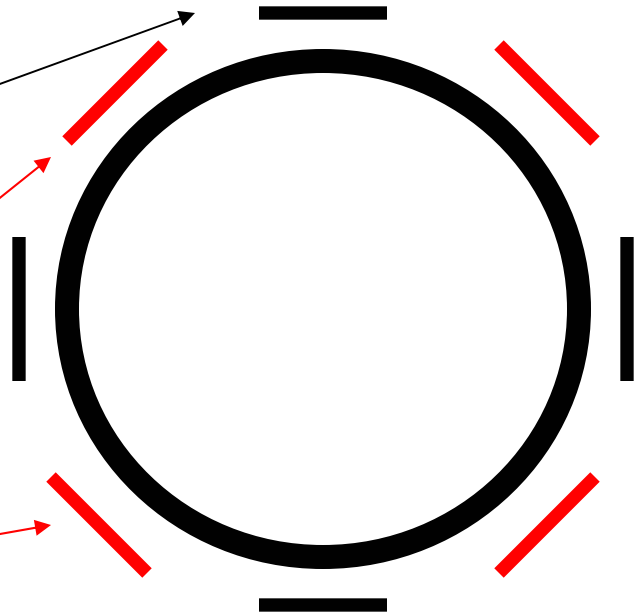


Representation of cross section of roll spanning large machine.

So its strength must be symmetrical about its axis of rotation!

The portions passing through the black areas are aiding in stiffness (think of an I beam).

The portions passing through the red areas are essentially dead weight or at least not as efficient as the horizontal and vertical regions.



The wider the span, the thicker the shell, but not all of the shell is working to solve the span problem, part of it is deadweight that further adds to the shell thickness.

Other roll problems

- Unlike beams in a building or bridge, which are designed to a strength parameter, any kind of roll in a paper machine is designed to a deflection parameter, a much more rigorous standard.
- The WK^2 issue.
- A papermachine roll can only be supported at the ends, making strength across the span as challenging as possible (no piers like a bridge).

What is the WK^2 Issue?

- WK^2 is “the rotating moment of inertia of a body.” A simple explanation can be found at http://tinyurl.com/yzvo77w
- Essentially, the bigger the diameter of a roll and the more it weighs, the bigger the drive components (bearings, connecting shafts, gearboxes, motors, electrical starters, electrical substations) must be to start it rotating from rest.
- ***Span adds installed costs and operating costs to all sorts of downstream and upstream components.***

Possible Solutions to the Roll Problem

- Lighter weight rolls
- Some way to support rolls in intermediate positions in order to eliminate the deadweight aspects.

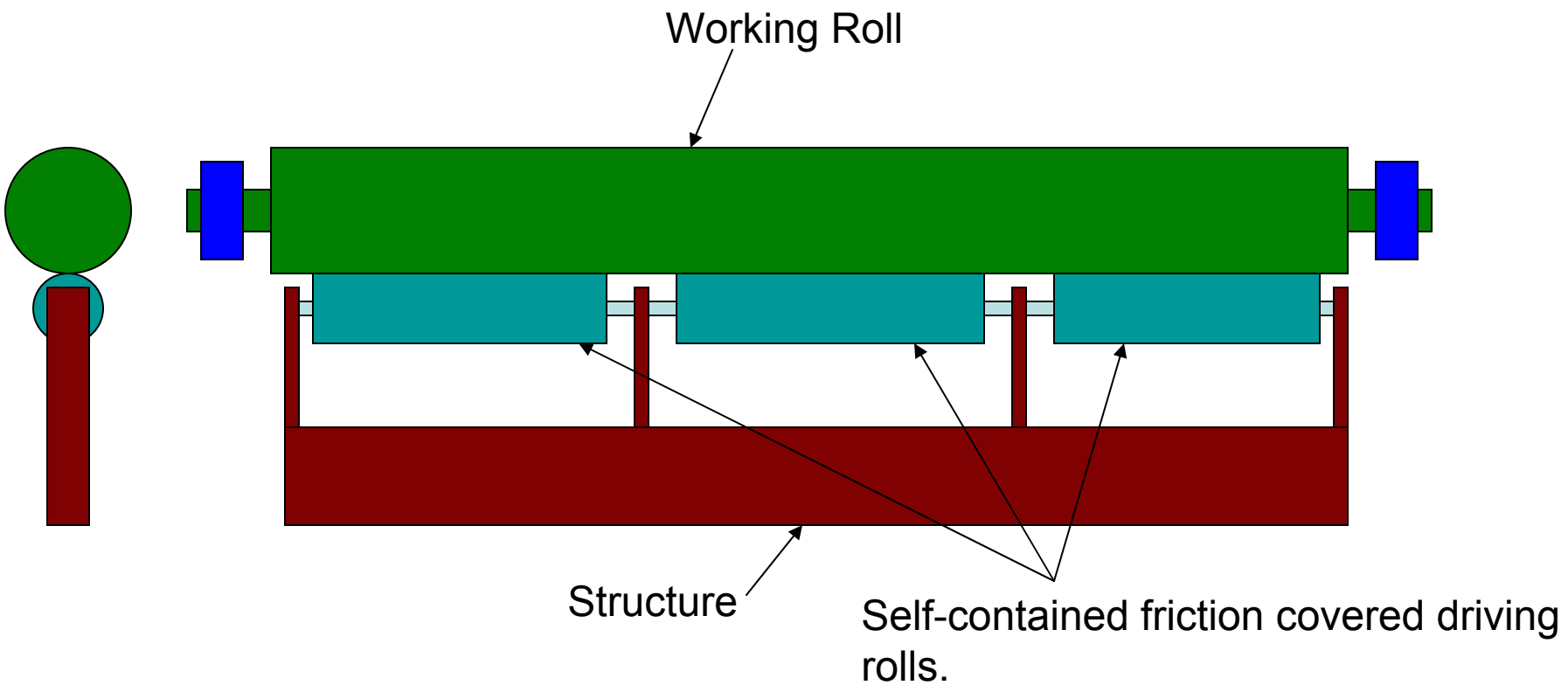
Voith is one company making lighter weight rolls.

- Their brand name is CarboTec and they are made from carbon fibers.

Voith* extols their virtues here: http://tinyurl.com/yhvwyy5

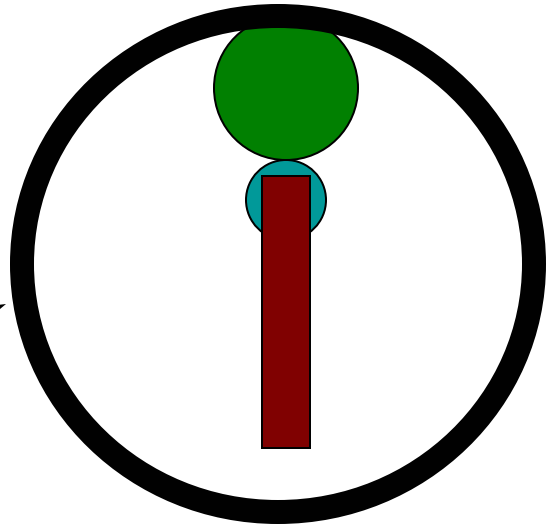
* Neither my company nor I have any commercial relationship with Voith at this time.

Or, build a roll that can be supported in the middle and thus is smaller in diameter:



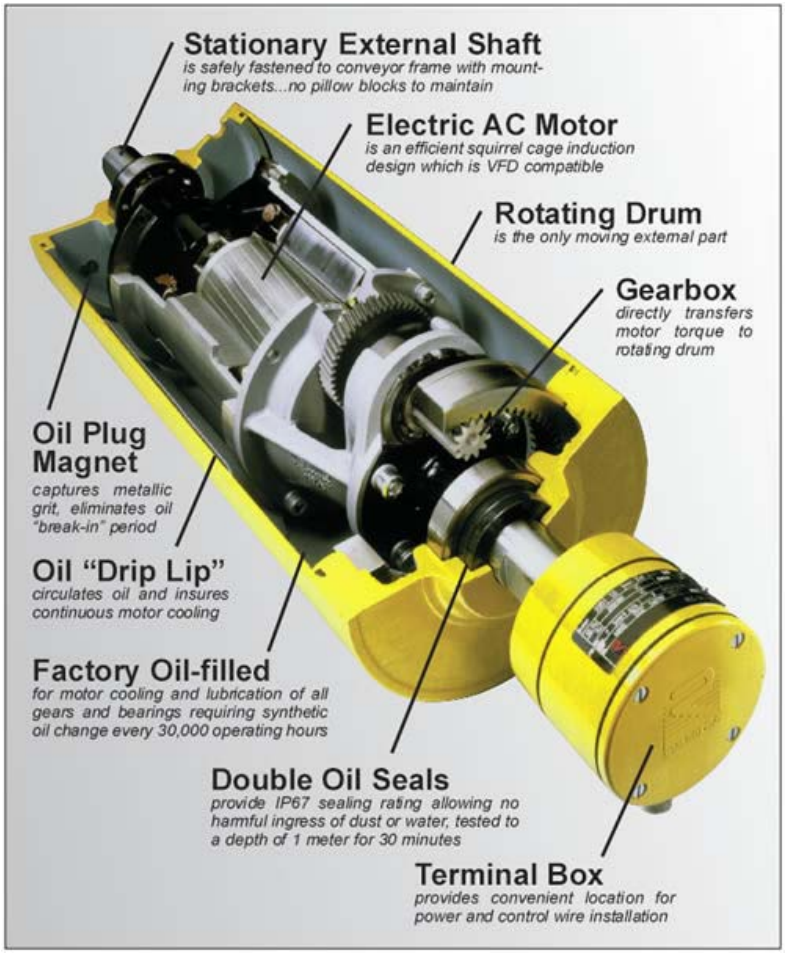
We end up with an improvement roughly like this:

One problem—the nip is not as wide as before.



Old style roll superimposed over new style for comparison.

What to use for the friction rolls?

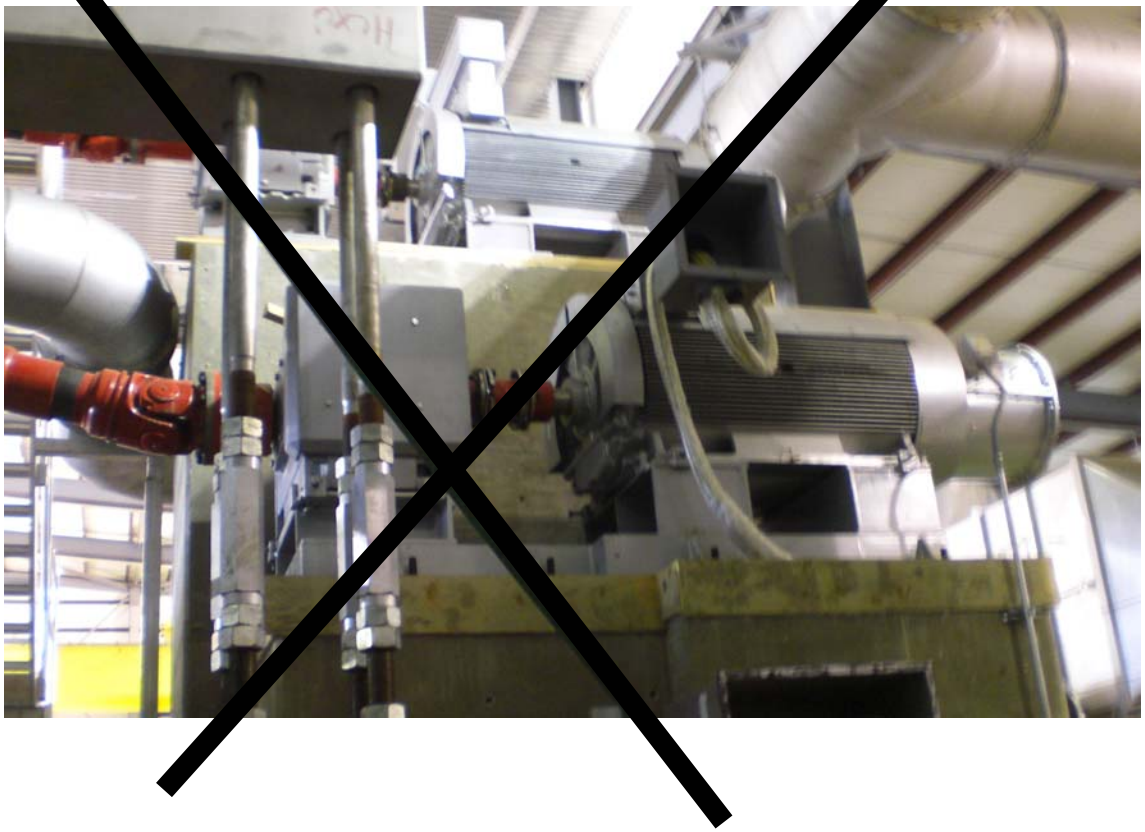


These are proven technology made by Rulmeca* Corporation.

* Neither my company nor I have any commercial relationship with Rulmeca at this time nor have we asked Rulmeca about the suitability of their rolls for this application.

But there is another bonus as well:

All of this goes away!



Other challenges

- There are many other static challenges to building the lightweight papermachine, however the rotating roll challenge seems, at the moment at least, the one with the most payoff if it can be solved.
- I hope you will get involved. Go to http://papermachine2025.ning.com/ and join for free.

Patents, copyrights, etc.

- Nothing in this presentation, except perhaps those items shown that are from Voith and Rulmeca, is or will be patented by the author. Check with Voith and Rulmeca if you have any questions about their products and patents.
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Other connections

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