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Discovering lower cost, higher quality and more sustainable crane mats

By WPED Contributor | June 16, 2020

Contributed article from World Forest Group

Time after time customers and prospective customers have told us the same thing: Crane mat quality is decreasing, mat prices are increasing, and 12-in. crane mats are harder to find. In addition, wind power technology is developing so rapidly that heavier and taller windmills are the norm and require bigger lifts and bigger cranes. We set out to try to build a better timber mat, the same mat that users are accustomed to but with better materials.

Historically, as many industries advance, demand increases and the raw material that supports the industry becomes both less abundant and quality decreases. This is not new.

In 1664, John Evelyn warned about the explosion of industry in Britain and the effect it had on timber availability. Over a 100-year period, timber fit for the British Navy had shrunk by 90%. Britain couldn't grow oak fast enough – but America had ample forests that could replace the missing raw material. The rest is history.

Unfortunately, exactly 400 years after the pilgrims landed at Plymouth Rock, the domestic timber industry is in much the same situation as John Evelyn's Britain. The once-abundant high-quality oak has been mostly cut down; tree diameter is smaller, and growing environmental awareness has restricted access to remaining high-quality stands. The domestic matting business is therefore left with low quality logs to make a product which the industry requires to be high-quality.

Finding new sources of raw material is one solution to decreasing abundance

and quality; technology and materials science can be another solution.

As a low-tech but critical part of the construction path, we've been exploring how to use historically effective approaches to the crane matting problem. We've rediscovered the same two time-honored mechanisms to come up with a better timber mat – focus on materials science and technology to create a better matting solution.

In our case, we looked first at materials and secondly at technology.

Materials: Our experience over the last 25 years has been finding wood species with superior working characteristics from tropical countries, managing those forest resources sustainably, and trying to make an industrial product that fits our customers' needs.

The best mats come from tropical hardwoods. For example, Ekki is a well-known and superior African wood. There are other species. The problem with most native hardwoods is that they are quite expensive, and the industry has not favorably viewed cost except in the most extreme lift requirements.

One tropical hardwood that displays superior strength characteristics is Eucalyptus. It has the advantage of being plantation-grown around the world and therefore is much more affordable than tropical hardwoods from rainforests. Using Eucalyptus as a replacement for the once abundant high-quality U.S. oak is our materials solution to the better matting problem.

Let's look at the numbers for a moment to see differences in material strength.

Mat type	Bending Strength (F_b)	Shear Strength (F_v)	Compression Perpendicular ($F_{c\perp}$)	Modulus of Elasticity (E)
Eucalyptus	2,000	265	970	1,300,000
Mixed hardwoods	1,400	200	750	1,200,000
Ekki	3,400	410	2,170	1,900,000

Figure 1 – Materials Properties for Three Crane Mat Alternatives (in PSI). Source: Duerr. Mobile Crane Support Handbook. 2nd ed. 2019. p. 115

Now, let's look at some rough numbers for cost per unit strength.

Mat type	US$ per Bending Strength (F_b)	US$ per Shear Strength (F_v)	US$ per Compression Perpendicular ($F_{c\perp}$)	US$ per Modulus of Elasticity (E)
Eucalyptus	$0.25	$1.89	$0.52	$0.00038
Mixed hardwoods	$0.36	$2.50	$0.67	$0.00042
Ekki	$0.25	$2.07	$0.39	$0.00045

Figure 2 – Rough cost per unit strength (PSI) various species. Source: Duerr. Mobile Crane Support Handbook. 2nd ed. 2019. p. 115

What we see is that domestic species cost more per unit strength than both natural or plantation-based tropical species. This makes sense. The domestic matting industry has to use small diameter logs with greater defects (lower strength) and must use mixed species. Pure oak mats are available, and some of the oaks have superior working characteristics superior to mixed hardwoods, but pure oak mats are more expensive and not as strong as Eucalyptus.

(Note that the analysis above simplifies the cost structure and ignores freight component. Eucalyptus is lighter than mixed hardwoods though stronger, which

means more mats/truck. Ekki, for example, is quite heavy, so that is fewer mats/truck. As crane mats are used repeatedly over time the freight cost component becomes a significant aspect of total cost of ownership calculations.)

Technology: The wind power industry is a stellar example of continual innovation of high-tech solutions to wind challenges. Think of the huge advances including improvements in turbines to blades to location siting to drone use and IOT solutions.

For the wood products industry much of the technology is well-known, established, and substantially developed and, compared with the wind power industry, are decidedly low-tech.

For example, every mat producer uses some kind of paint or end-sealant to protect the end of the mat timbers. That's to prevent cracking and splitting. World Forest Group uses the same practice on its timber mats, but we add an end-plate to the timber ends. End plates are forest industry standard for all large timbers; look at trusses, large post and beam construction, and other large timbers, and you'll generally find end-plates.

Another example is using square timbers. Partly, we can use square timbers because our logs are larger and we are cutting specifically for crane mats, not for grade timber. And, partly, we choose to standardize around a more costly square timber for our manufacturing process. What's the value of square timbers instead of timbers with rounded edges? There are four advantages.

1. The buyer pays for wood, not for bark or air.
2. Using square timbers helps us make a standardized Eucalyptus mat. Standardization means every mat is the same with the same working characteristics. And, they are safer because men, machines, and materials are working on a level surface.
3. Square timbers mean flat surfaces. That means less wear and tear from the machine.
4. Square timbers mean that the bolts grip solidly.

Other technological solutions to the same dwindling quality and supply problem exist – laminated mats are one example.

One challenge we've faced is right-sizing our mats to the job. For example, many lifts aren't as heavy as the example above and a 10-in. Eucalyptus mat will serve just as well as a 12-in. mixed hardwood mat. A 12-in. Eucalyptus mat is about 40% stronger than a mixed hardwood mat. For those heavy lifts that use two 12-in. mixed hardwood mats, could we save customers money by replacing them with two 10-in. Eucalyptus mats? Worth investigating. And, for the lighter lifts, could an 8-in. Eucalyptus mat serve as a replacement for jobs that typically use 12-in. mixed hardwood mats but don't really need that strength? (8-in. Eucalyptus is roughly equivalent to 9.5-in. mixed hardwood.)

Conclusion: Stronger crane mats will become increasingly important to the wind power industry. We can take lessons from material science and technology to find stronger, standardized, safer and more affordable crane mat solutions.