New structural products from small diameter pine trees

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Wider may be better but in the case of beams, deeper is much better

For rectangular beams
section modulus
$Z = bh^2/6$

Bending stress = M_{max} / Z

Wider may be better but in the case of beams, deeper is much better

For rectangular beams
section modulus

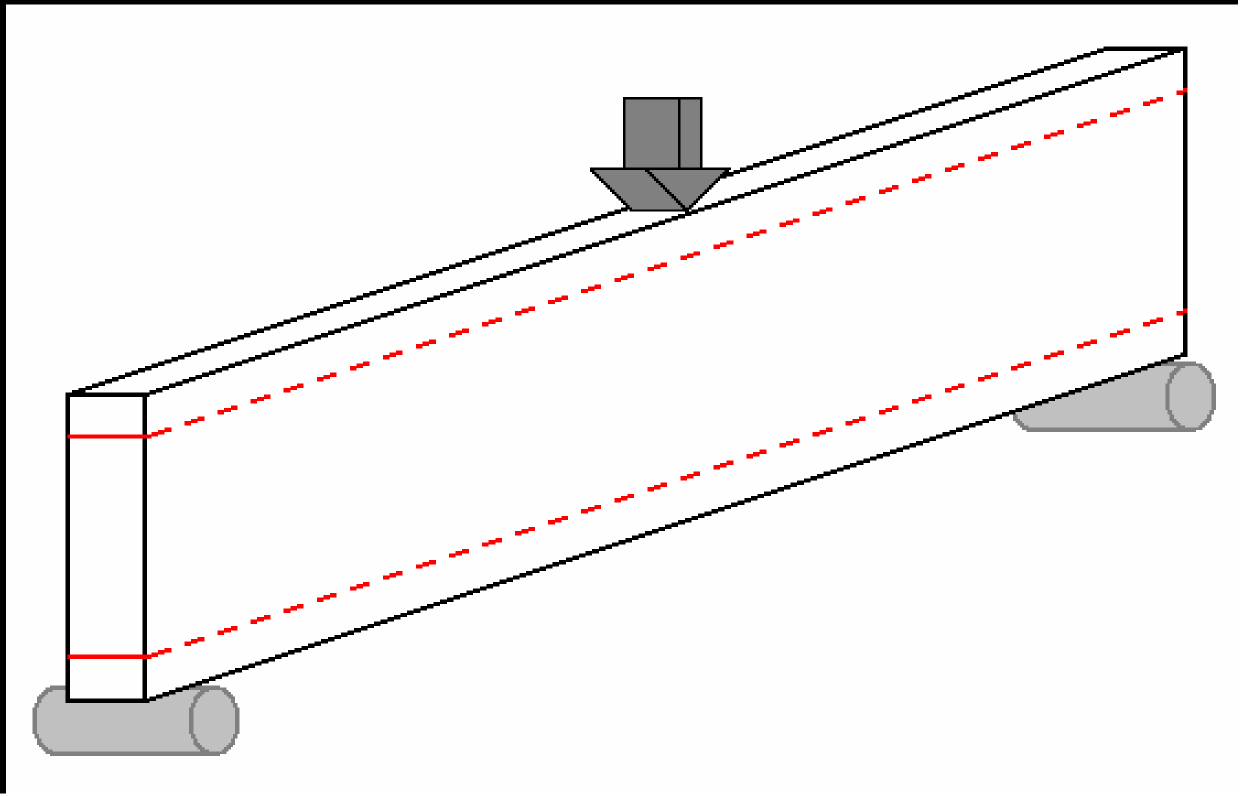
$$Z = bh^2/6$$

Doubling the width cuts the stress in half & doubles the capacity

Doubling the depth cuts the stress by 75% & quadruples the capacity

$$\text{Bending stress} = M_{max} / Z$$

- The material closest to the extreme fiber (top and bottom edges) is the most influential with respect to beam strength.
- For a rectangular beam, half of the strength is developed in the upper and lower 15% of the material.

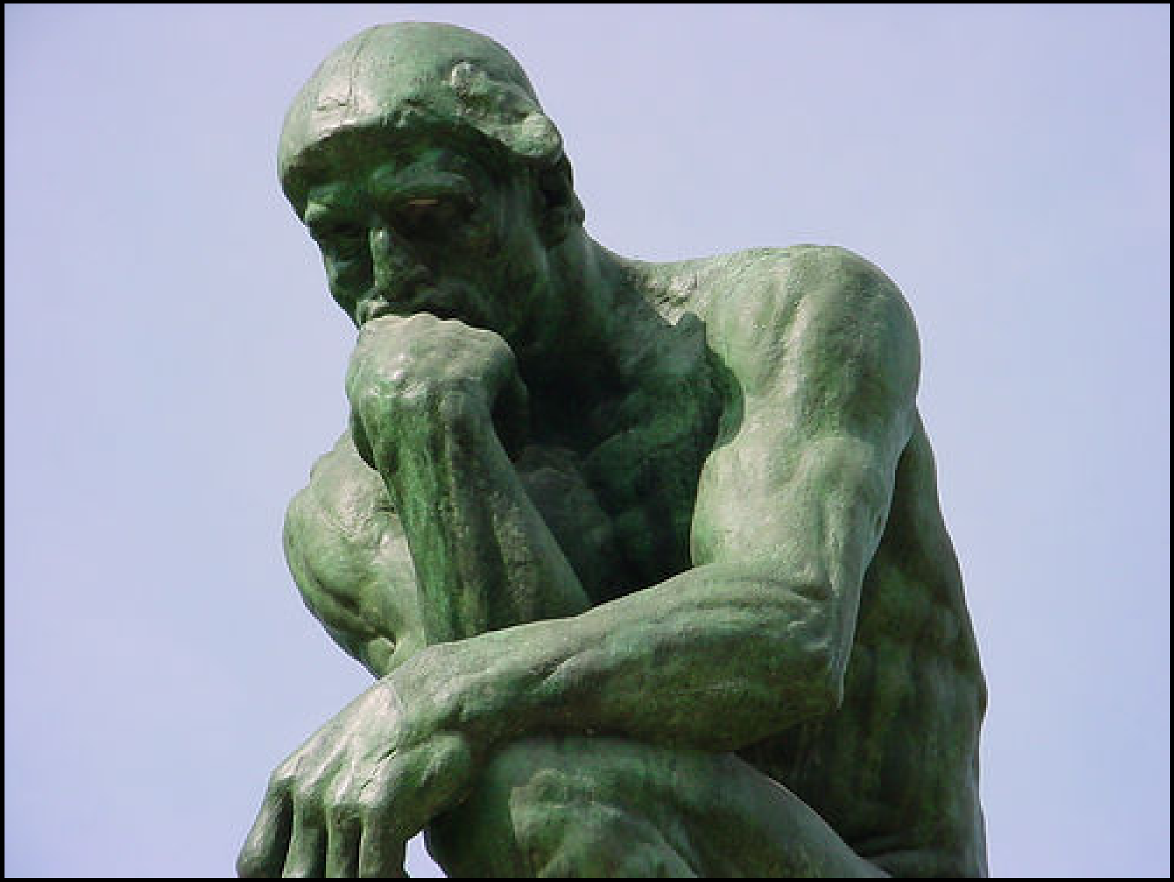


We take advantage of this by putting more material or better material at the extreme fiber





Question: How to take cost efficient small diameter wood, add a minimal amount of processing, & develop high-value products that take advantage of favorable engineering?

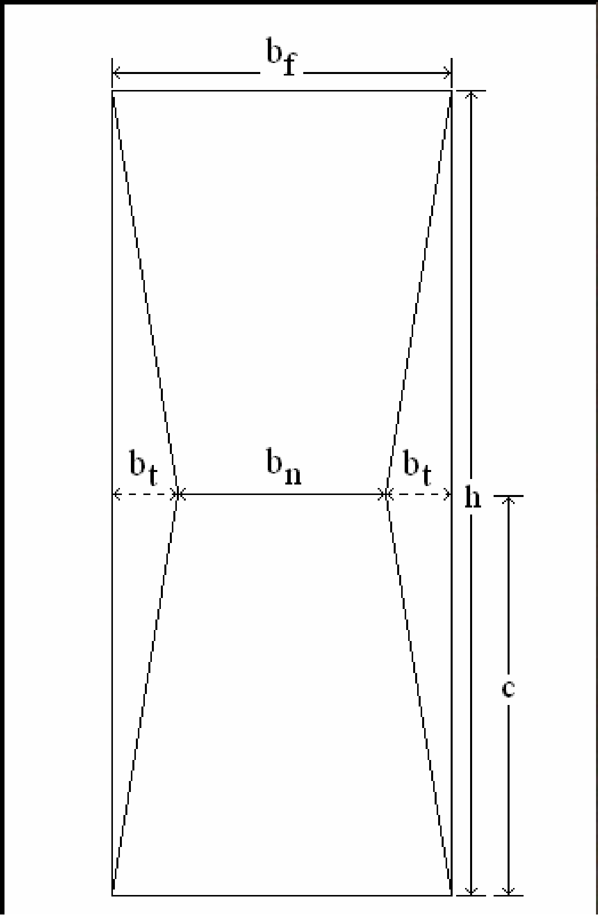


Question: How to take cost efficient small diameter wood, add a minimal amount of processing, & develop high-value products that take advantage of favorable engineering?



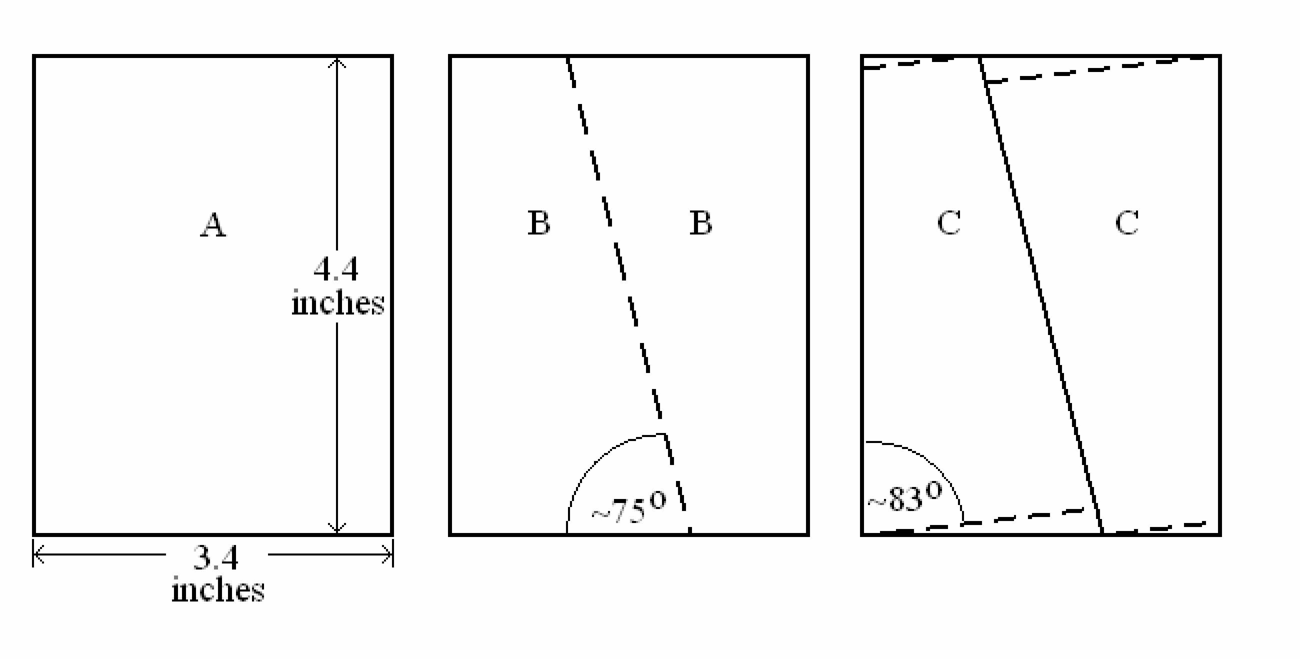

One possibility: bowtie-section beams

Minimally process rectangular cants rather than heavily reduce and reconstitute the wood into composites



Idea, compete with solid 2x8s, 2x10s, & 2x12s
Example: 2x8 & bowtie comparison

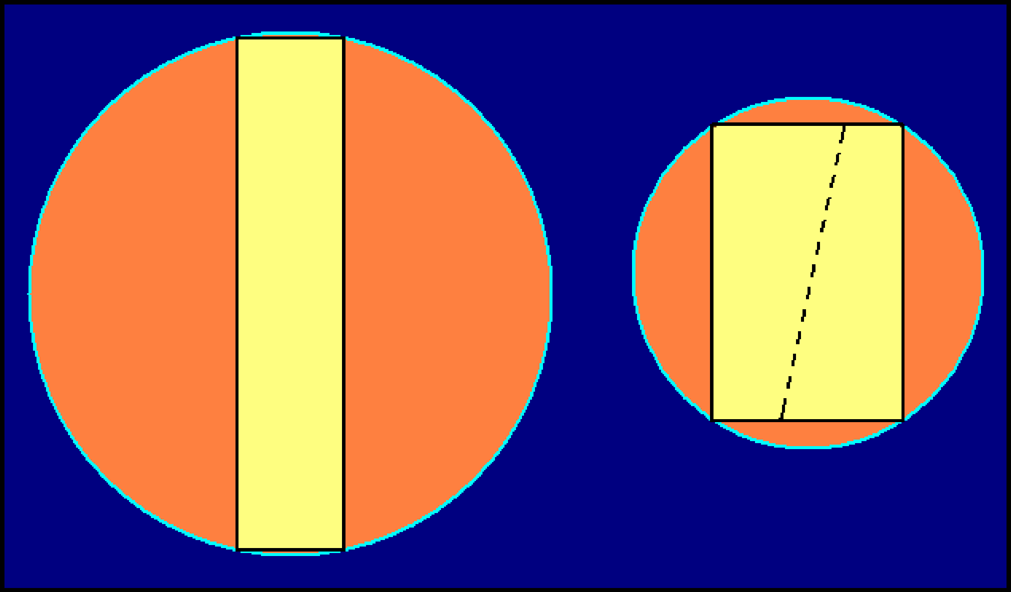
Saw rectangular cants from small diameter trees
Resaw matching trapezoids
Resaw into symmetrical trapezoids
Joint edges, NDT, assemble, test



Idea, compete with solid 2x8s, 2x10s, & 2x12s

Example: 2x8 & bowtie comparison

- Saw rectangular cants from small diameter trees
- Resaw matching trapezoids
- Resaw into symmetrical trapezoids
- Joint edges, NDT, match, assemble, reNDT, test





Name	Bowtie-8	2x8
Initial cant section width (inches)	3.4	2
Initial cant section depth (inches)	4.4	8
initial cant section area (inches^2)	14.96	16
Wood use comparison	93.5%	1
Theoretical minimum log small end diameter (in.)	5.56	8.25
Maximum final member width (in.)	2.01	1.5
Minimum average bowtie width (in.)	1.18	na
Final average depth (in.)	7.67	7.25
Moment of inertia, I (inches^4)	67.7	47.6
Section modulus, z (inches^3)	17.7	13.1
Relative mechanical efficiency (z comparison)	134%	100%
Theoretical relative strength to weight ratio	144%	100%
MOE design value (million psi), No. 1 pine	2.26	1.7
Fb design value, psi (bowtie & No. 1 pine lumber)	1469	1500
Moment capacity, Fb*z (pound inches)	25933	19711
Relatively moment capacity ratio vs No. 1	132%	100%
Efficiency factor: moment capacity / cant area	1733	1232
Relative efficiency (bowtie vs solid)	141%	100%

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