

**EWPAAs Annual General Meeting
November 2010**

**Optimisation of structural properties
- Resource to final product**

Hank Bier, Rotorua, New Zealand
Presented by Simon Dorries

Topics

- 1) **Why** grade veneer?
 - Some background
- 2) **How** is veneer graded?
 - Which is the best way?
- 3) **Opportunities** for optimising properties
 - making predictable products
 - some challenges

BUILDING MATERIALS

Factors affecting strength properties

- **Steel**

factory controlled mix of carbon, iron, etc.

Properties Uniform

- **Concrete**

controlled mix of water, cement, aggregate

Properties Uniform

- **Wood ? ?**

TABLE 2.1

**HARDWOOD TIMBER — STRENGTH GROUP CLASSIFICATIONS,
JOINT GROUP CLASSIFICATIONS AND DESIGN DENSITY
FOR SOME COMMON SPECIES AND GROUPS OF SPECIES**

Species	Moisture condition	Strength group (see Note 1)	Joint group	Design density (see Note 2) kg/m³
Mixed Australian hardwoods (excluding rainforest species) from S.A. and southern N.S.W.	Unseasoned	S4	J3	1 050
	Seasoned	SD4	JD3	650
Ash-type eucalypts from N.S.W. Highlands, Victoria and Tasmania	Unseasoned	S4	J3	1 050
	Seasoned	SD4	JD3	650
Non-ash-type eucalypts and Corymbias from Qld and N.S.W.	Unseasoned	S3	J2	1 150
	Seasoned	SD3	JD2	750
Rainforest species	Unseasoned	S7	J4	800
	Seasoned	SD7	JD4	500

Extract for AS1720:1997 Did we really know the properties of mixed species?

Hardwood

leaves

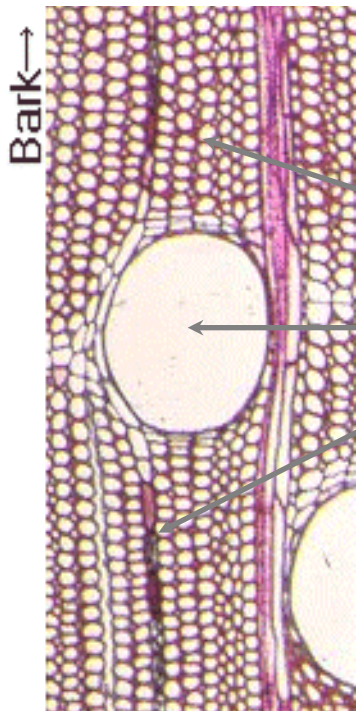


Softwood

needles and cones

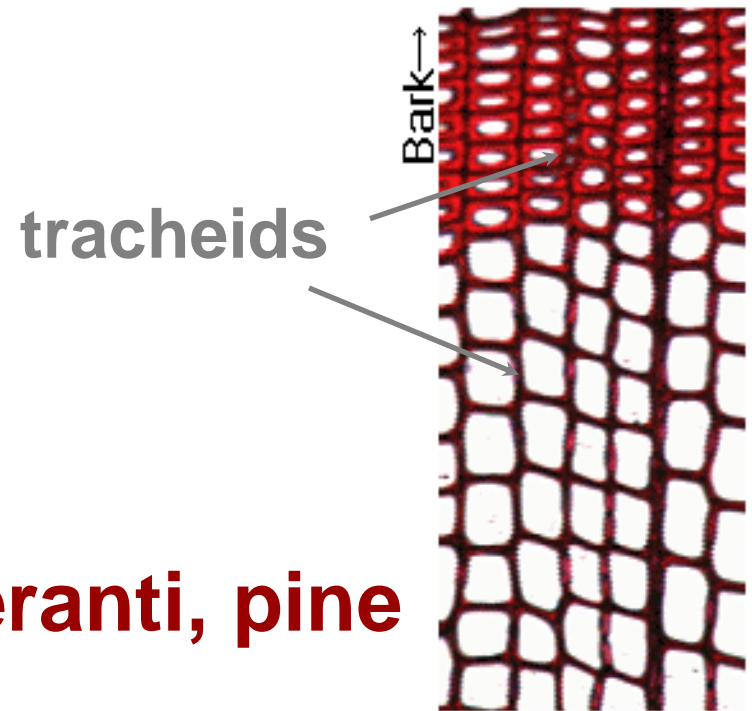


Species?



Bark →
fibres
vessels
store cells

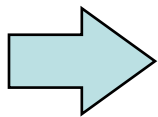
eucs, poplar, meranti, pine



Bark →
tracheids

Variation within species?

- Geography
 - aspect, climate, soil
- Silviculture
 - stocking (trees/hectare), pruning, thinning
- Individual traits
 - age of tree, position in tree, genetics

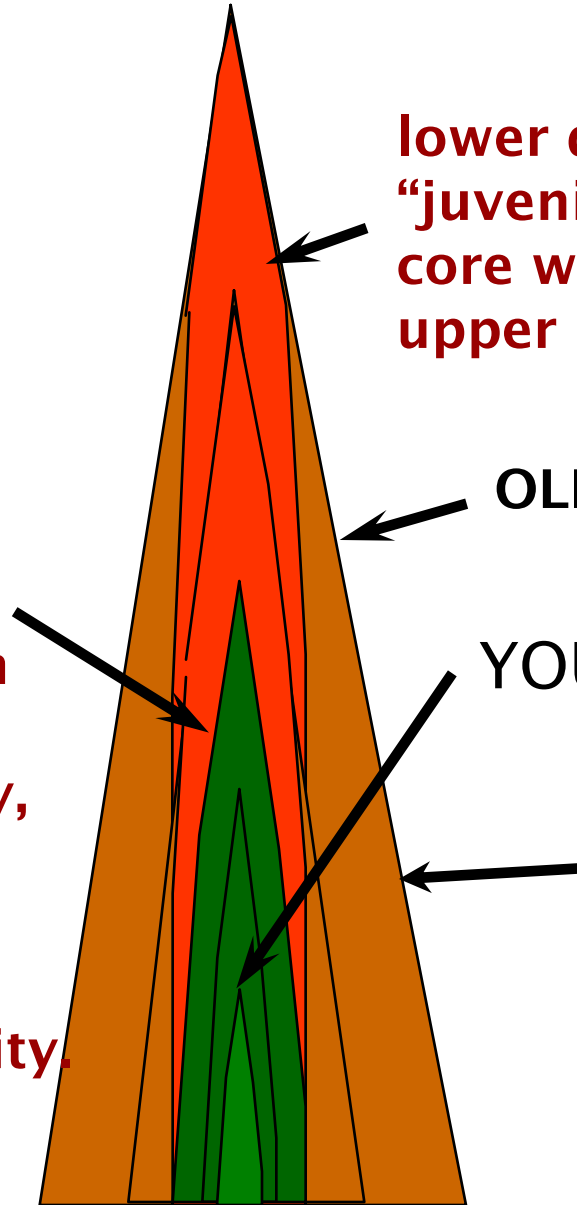


VARIABLE MATERIAL



Variation in the tree

“juvenile”
core wood, in
lower log,
lower density,
spiral grain,
propensity
for twist,
high variability.



lower density,
“juvenile”
core wood, in
upper log

OLD TREE

YOUNG TREE

higher density,
straight grained
“mature”
outer wood

Younger rotation age

- **Higher proportion core wood in pines**
- **lower strength properties**
- **more variability**



What trees have I got?



Variation occurs

- within sheets



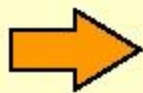
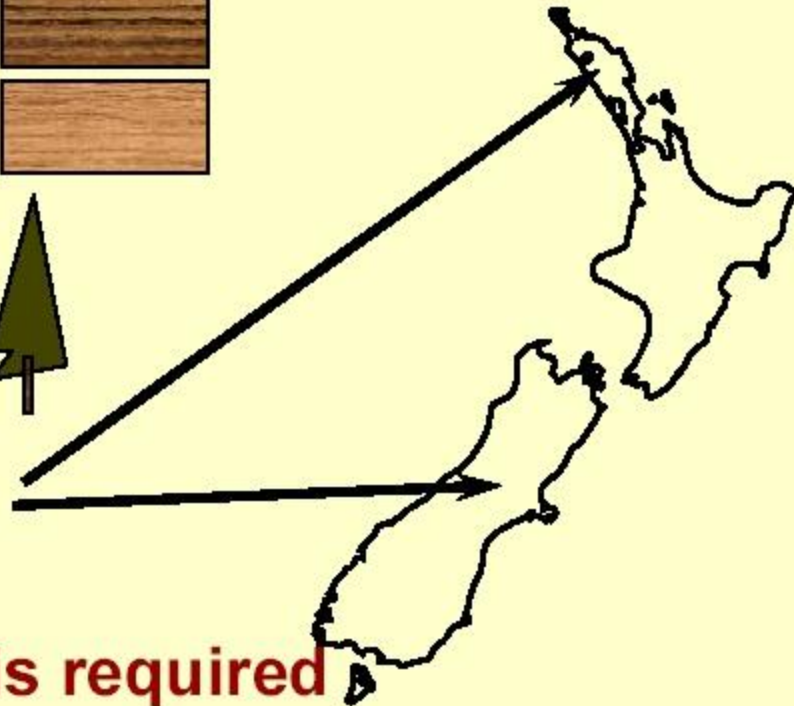
- between sheets



- between trees



- between sites



grading is required

Variation in wood

- **Mixed species**
- **Within Species**
- **Younger rotation age (harvest age)**
- **Variation in a single log can be more than between logs**

- **MUST design in consistency BUT**
- **need better grading methods**

Strong, stiff wood qualities

- **straight grain**
- **density**
- **small knot size**

Also impart:

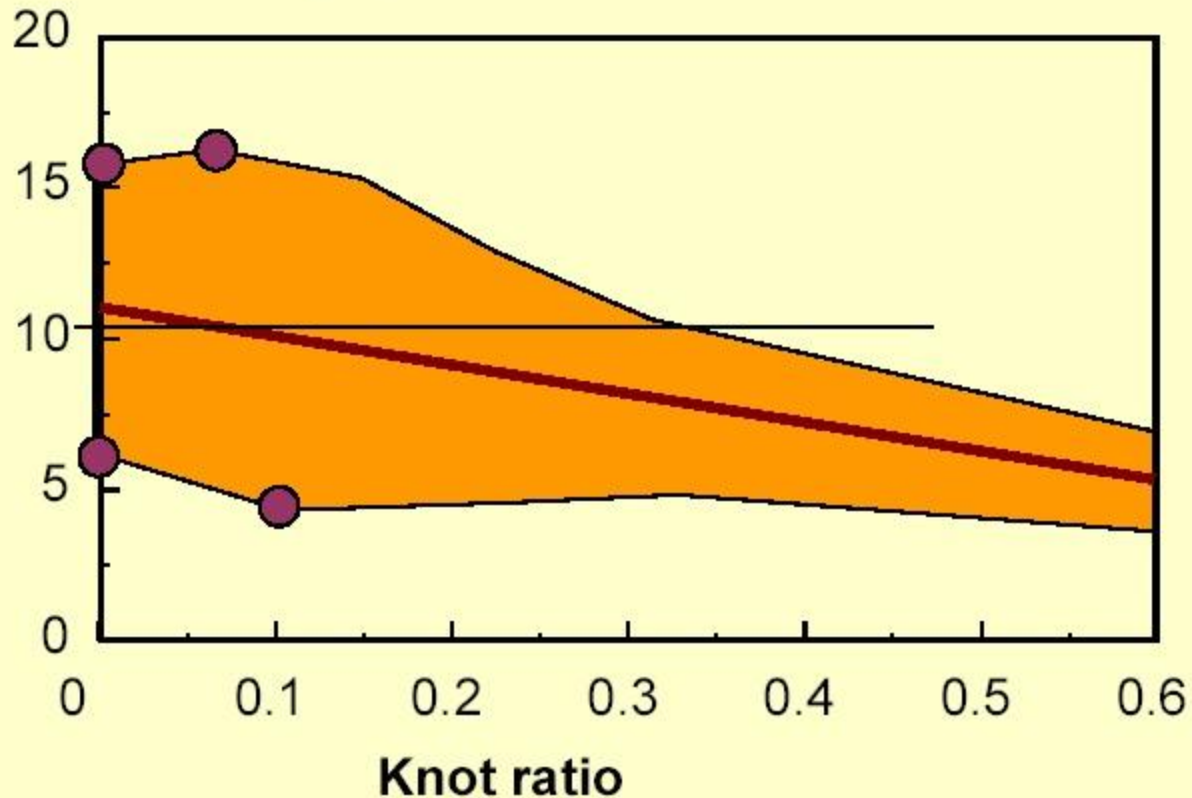
- **straightness, flatness, and stability**
- **stiffness and strength**
- **good fastening performance**
- **ease of use in construction**

The strength and stiffness of wood:

- microfibril angle
- grain angle
- knots
- density
- sound velocity

Knots and stiffness (FRI data)

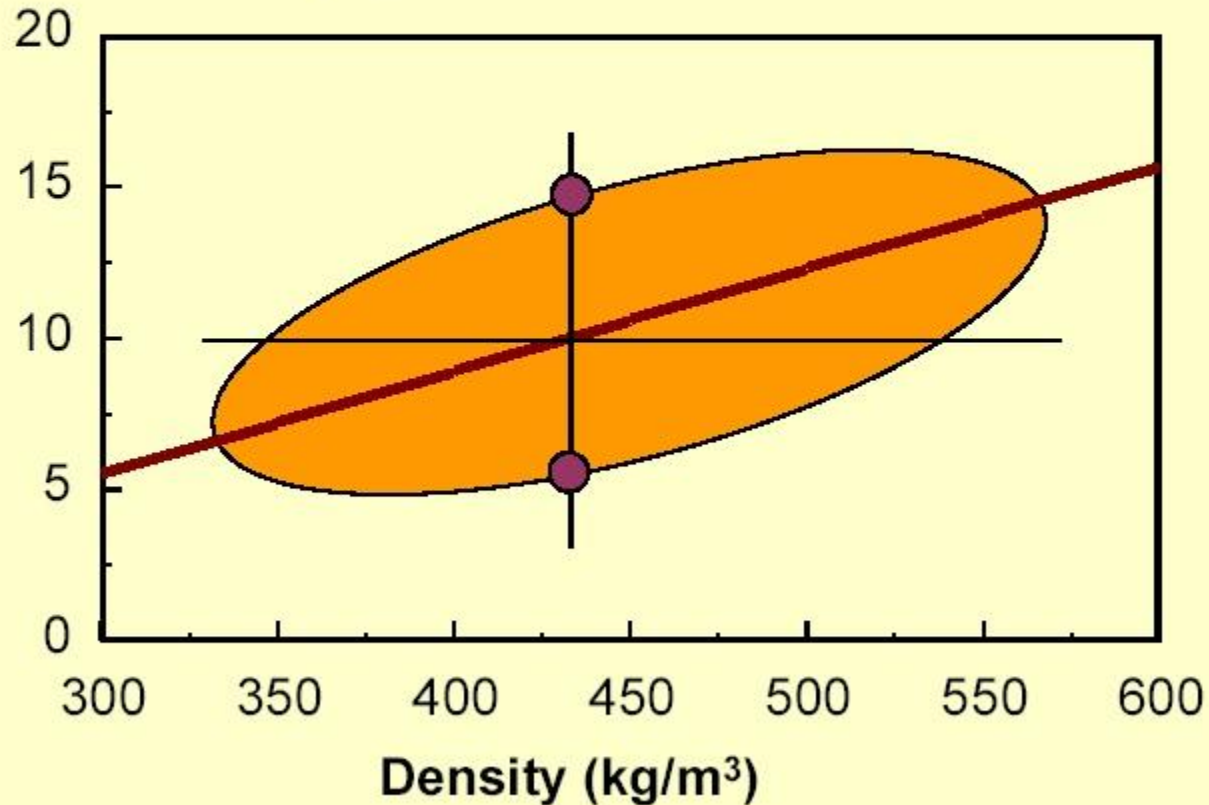
Stiffness (E)



There are very different properties with one knot measurement

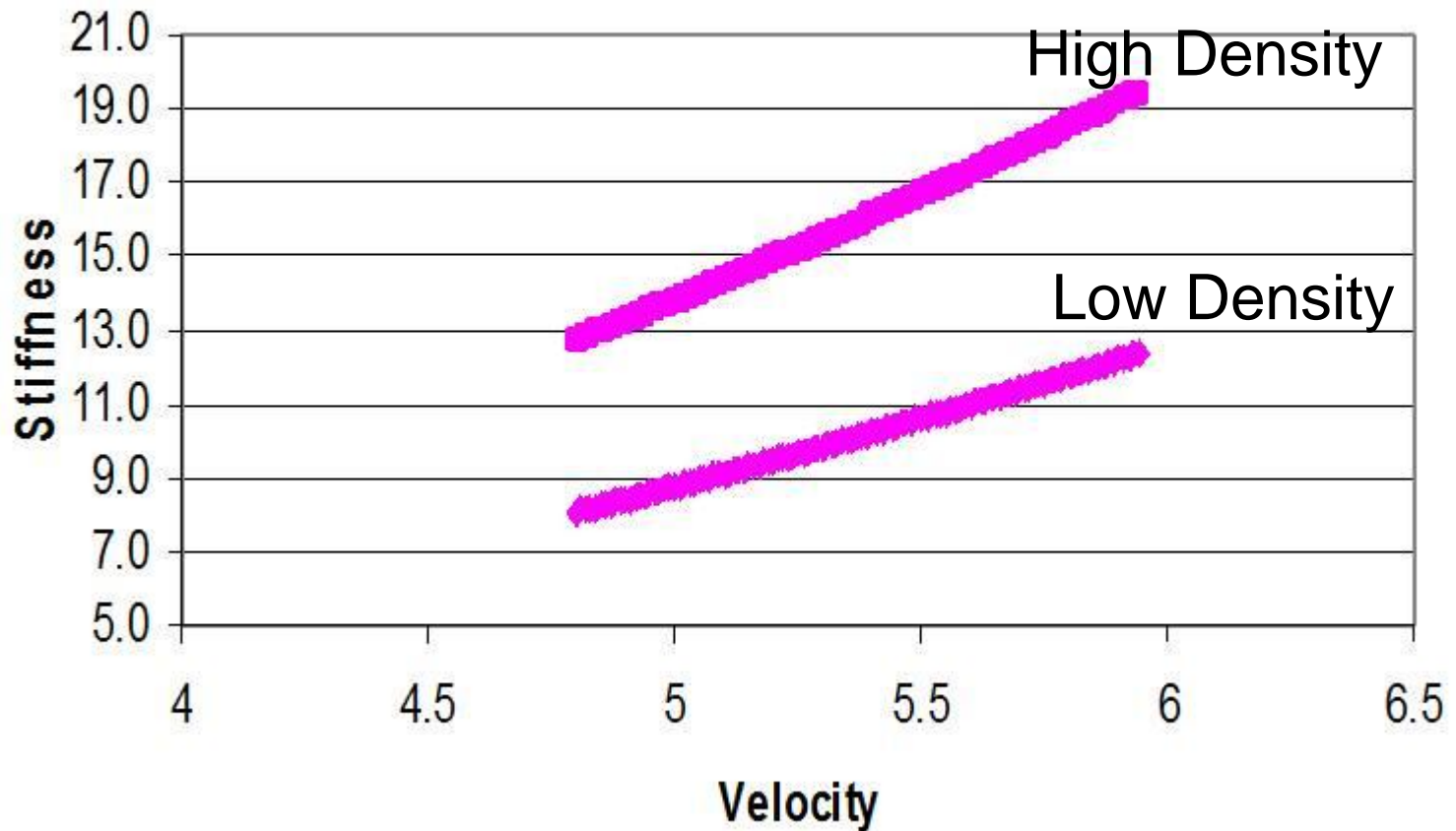
Density influences stiffness

Stiffness (E)



There are very different properties with one density

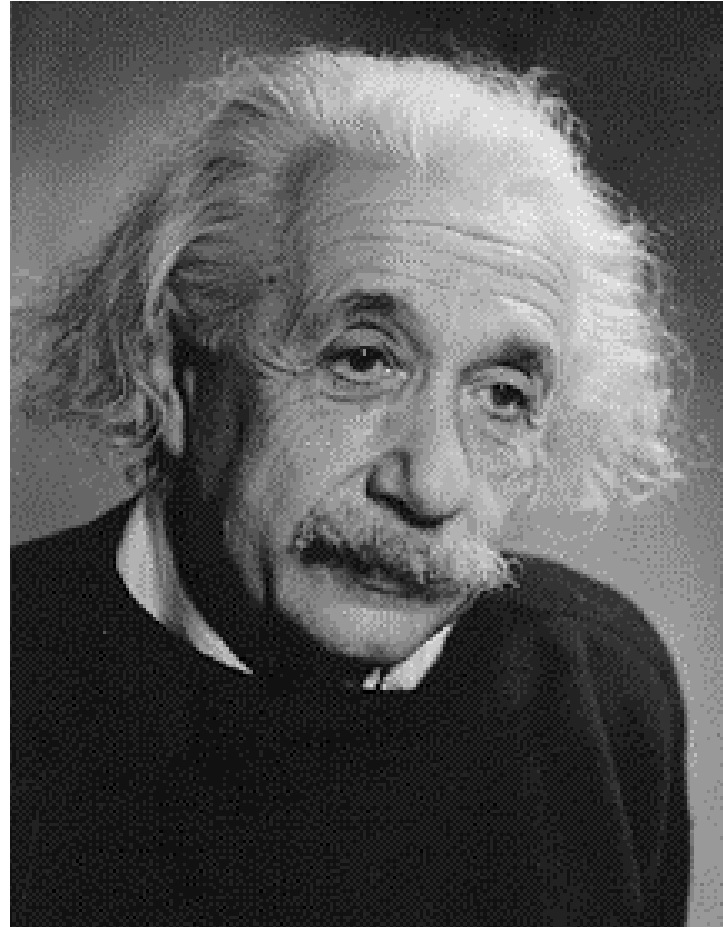
Stiffness vs. Sonic Velocity



sound speed + density = one MoE

Engineered wood and Einstein's Equation




$$E = mc^2$$



Can we measure it ?

- microfibril angle
- grain angle
- knots
- sound velocity
- density
- with difficulty
- not easy
- visual ineffective
- YES
- Qualified yes

Evolution of veneer grading (filling in the blanks in $E = \rho v^2$)

- Ultrasonic Propagation Time (UPT) 
- Density (and Moisture Content) 
- Grading by E (Combining UPT and Density) 

SOUND SPEED = distance/time(Ultrasonic propagation time UPT)

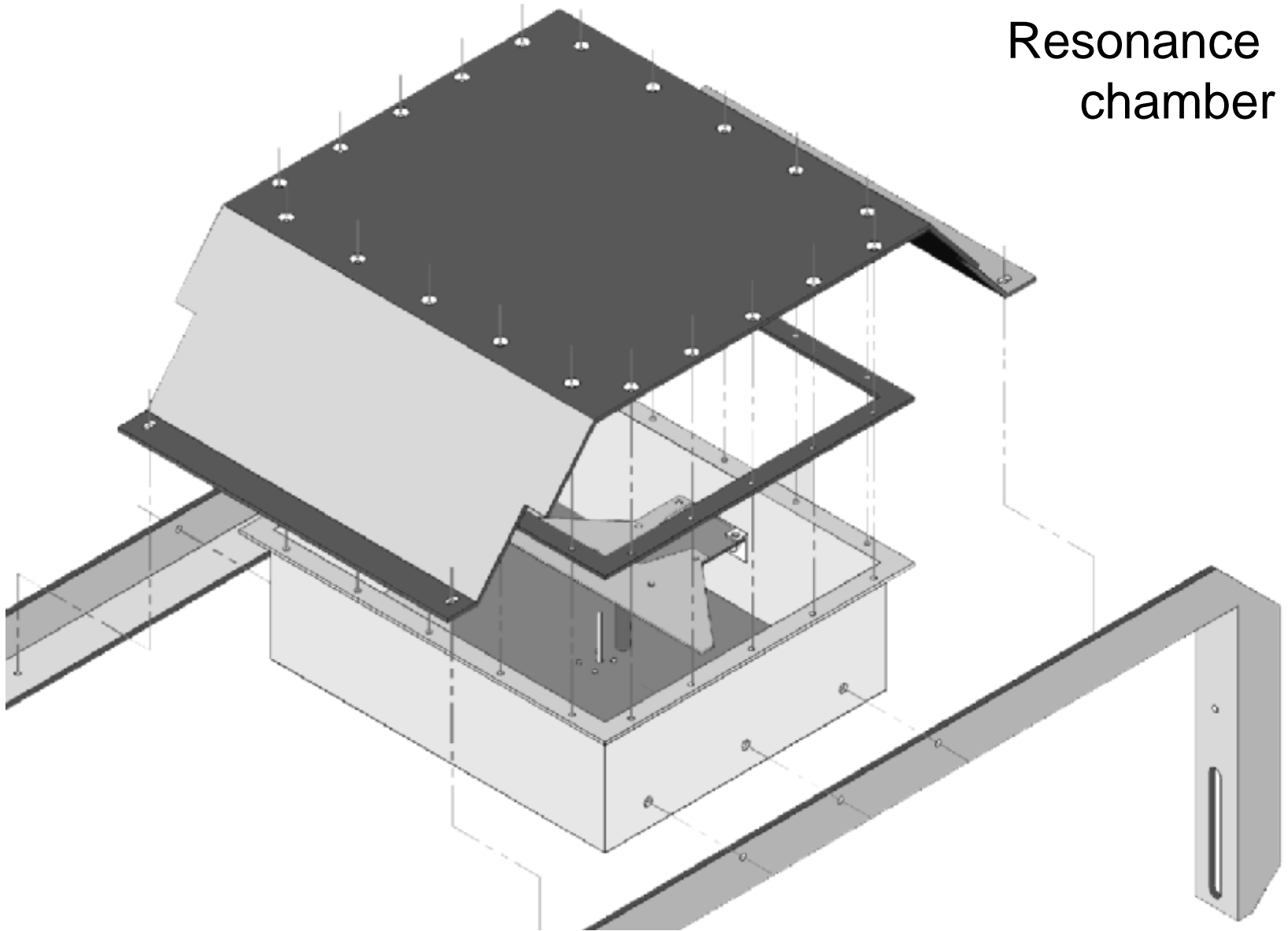


E Grading – Sound + Resonance

- Ultrasonic & radio frequency
- Measurement of E ($E = D * v^2$)
 - low variability in final product
 - E a predictor of MOR
- Embedded PC data processing
 - High speed
 - Temperature correction
 - Moisture content
 - Width measurement
 - Data collection

DENSITY

Resonance
chamber



DENSITY

Resonance chambers

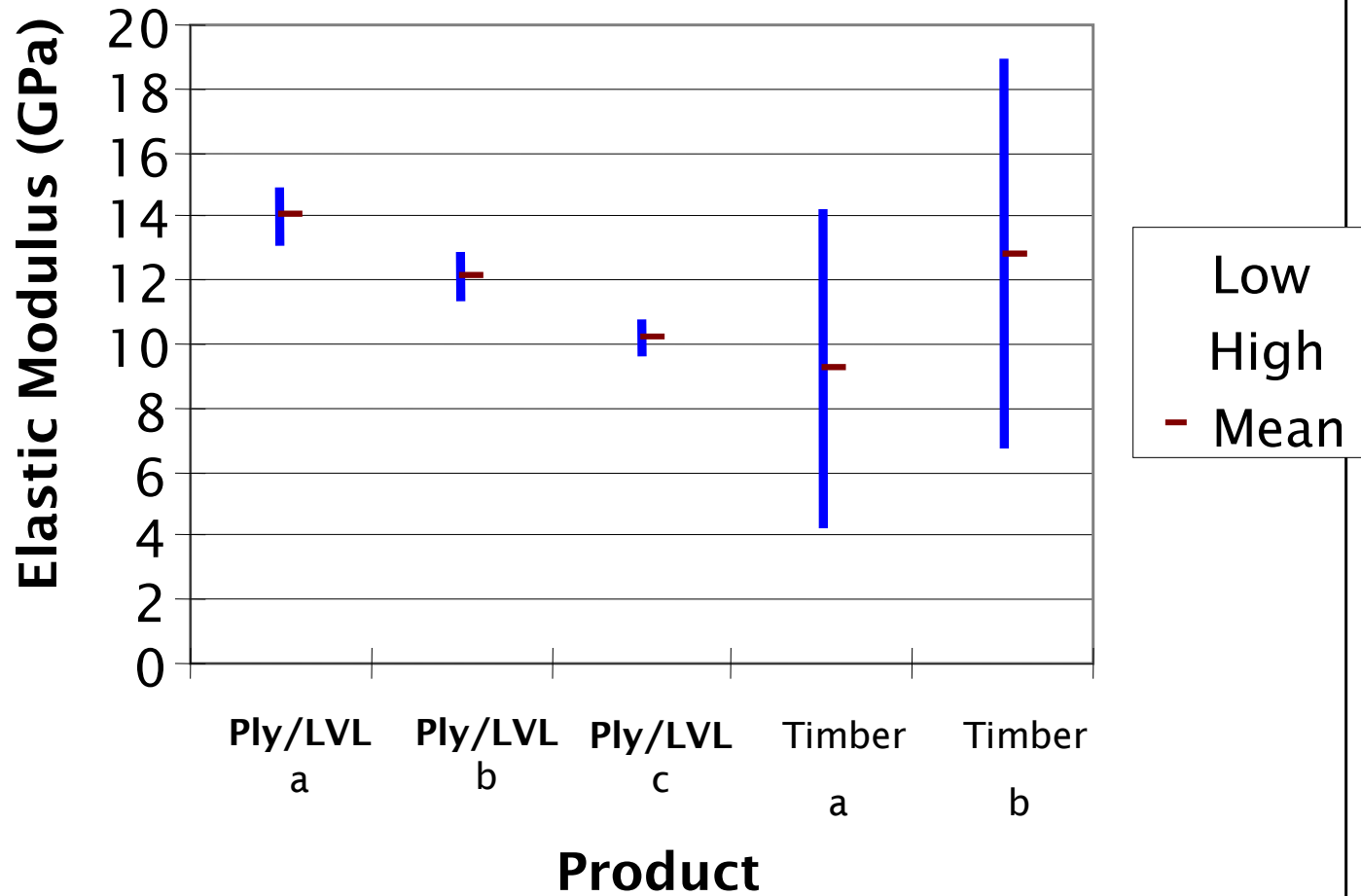


Metriguard

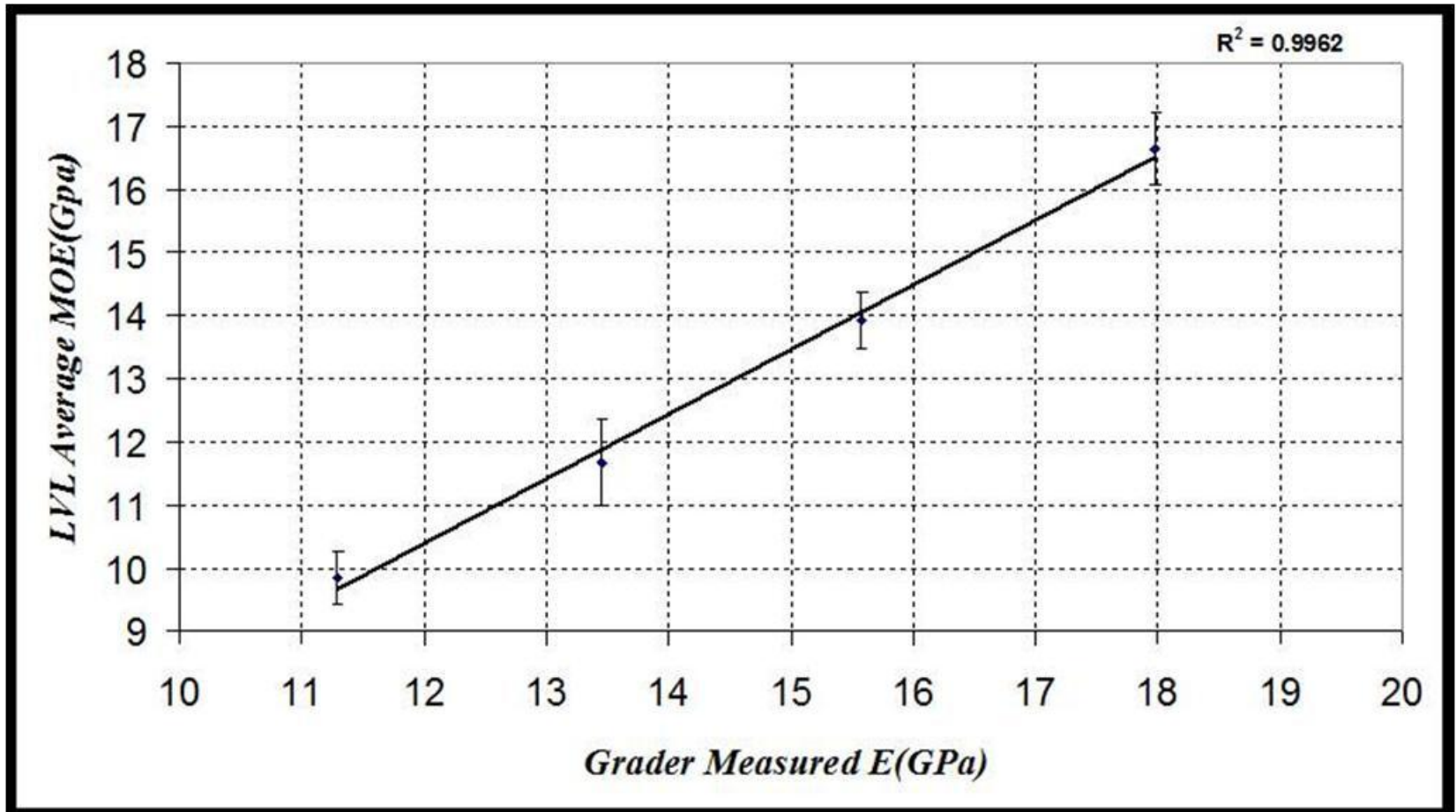


OUTFEED BELTS

E Grading produces low variability



LVL MOE vs. Grader E



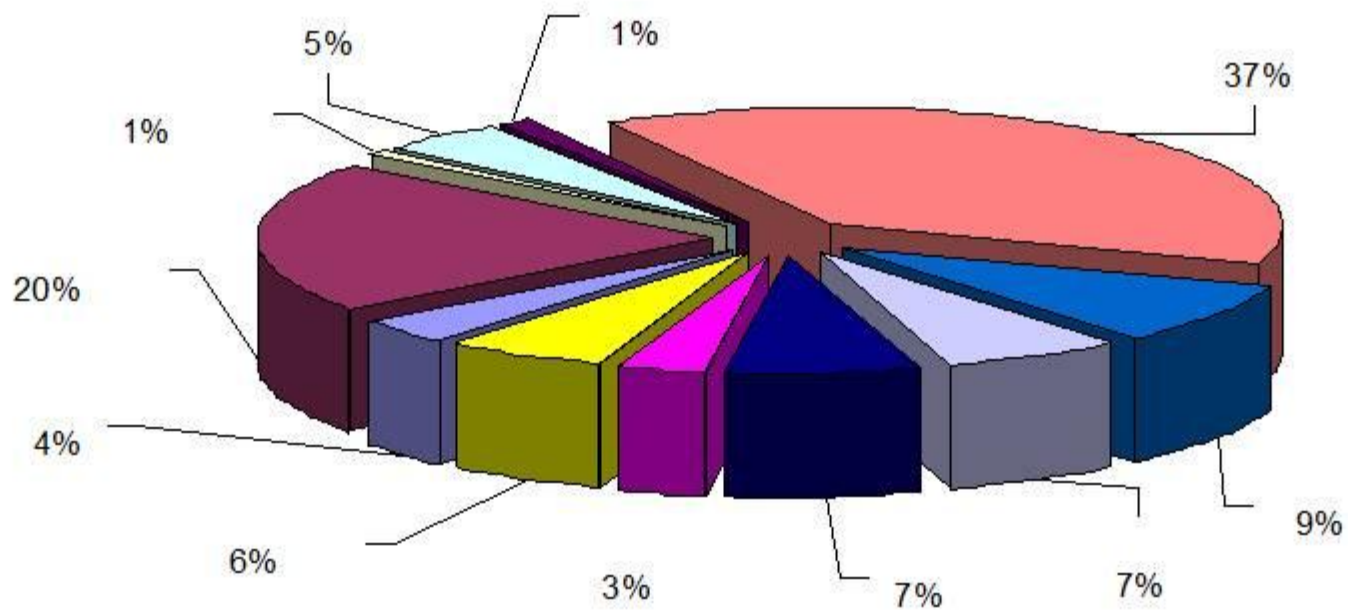
Not necessarily 1 to 1: But highly correlated

How does it work in the mill?

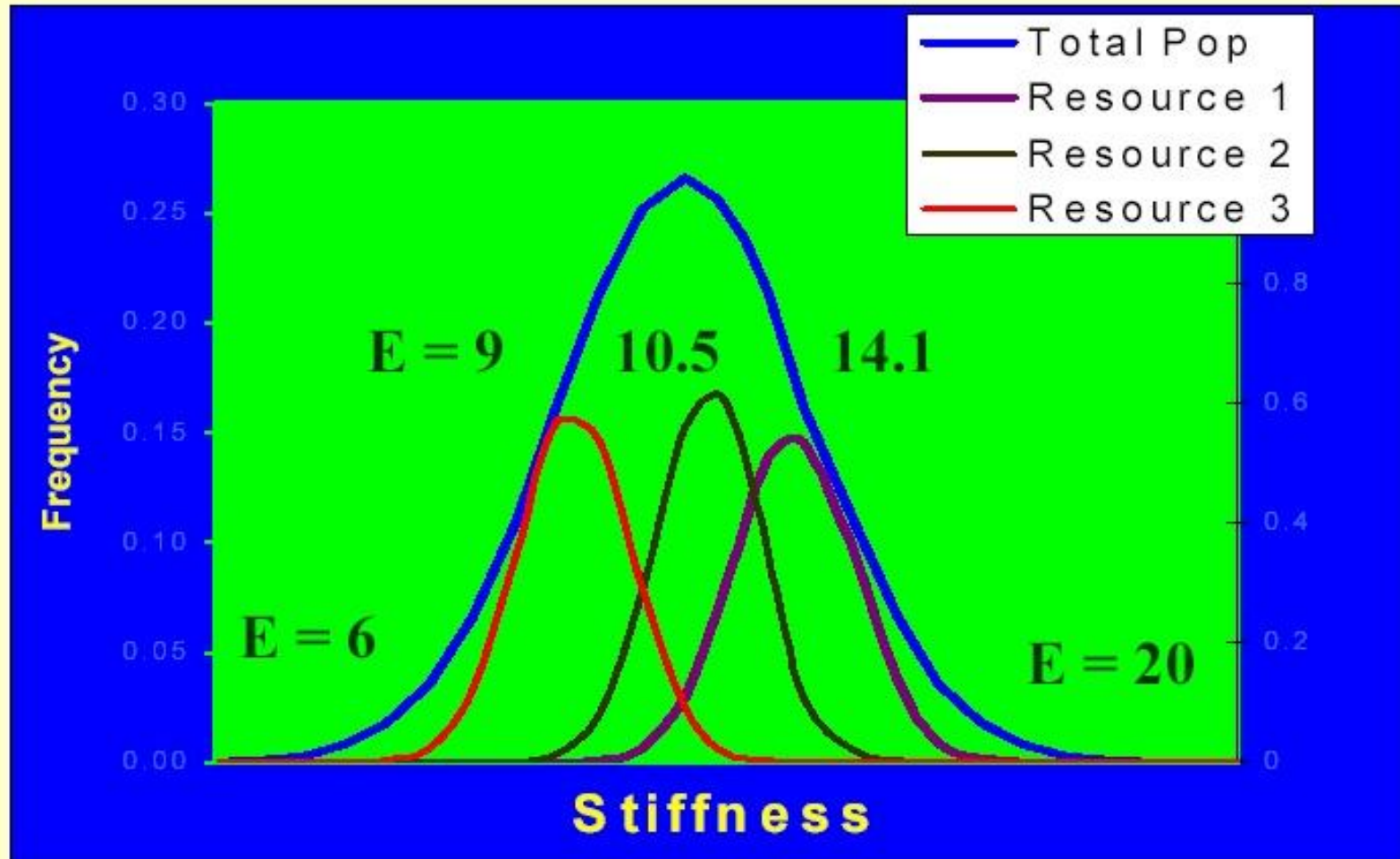
- the wood resource
- grade cut offs
- plywood in bending
- pitfalls
- resource-product balance
- another lever

So where do you get your trees?

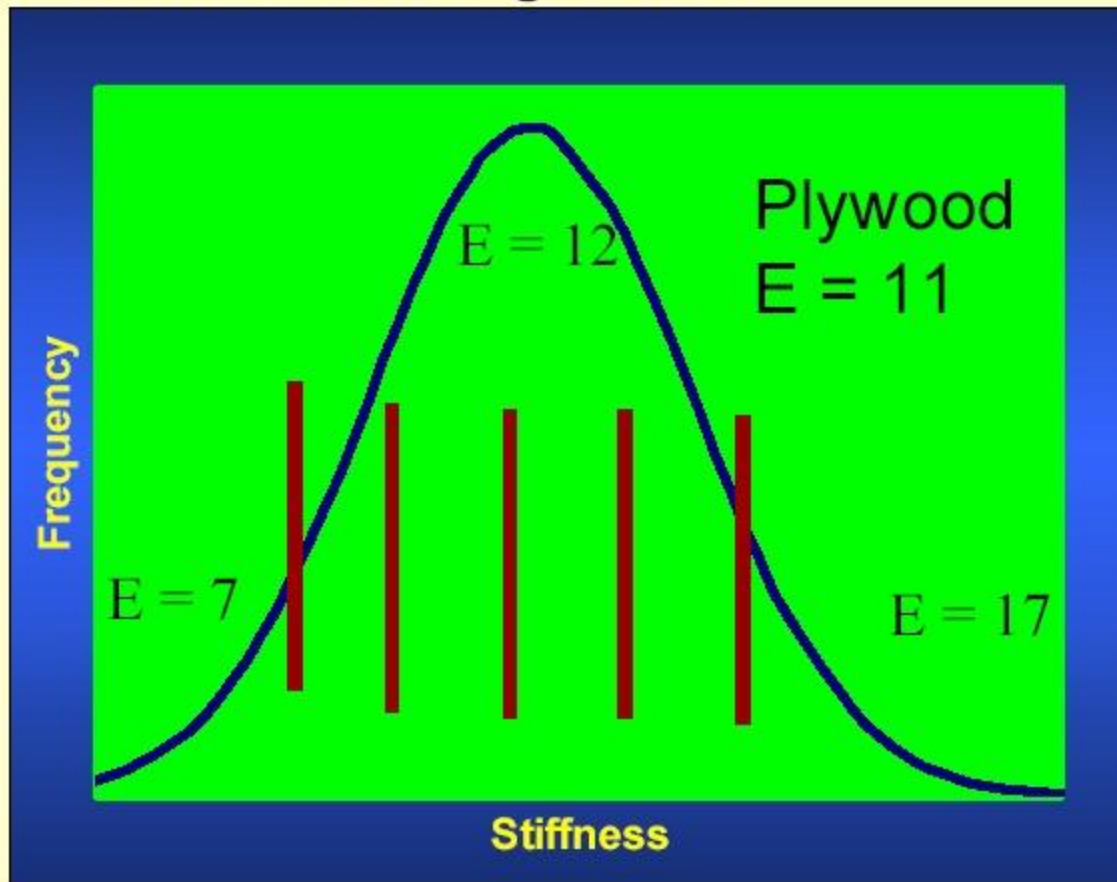
Log deliveries from a dozen different Forests



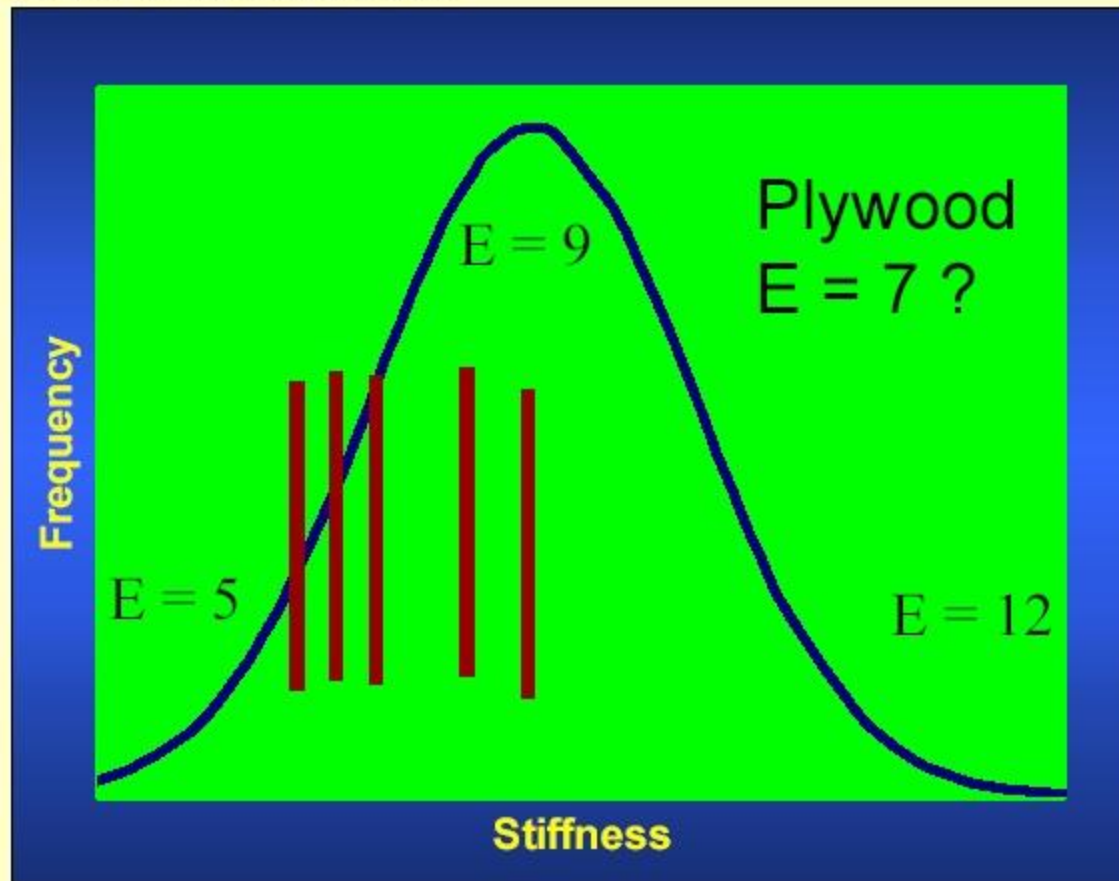
So where do you get your trees ?



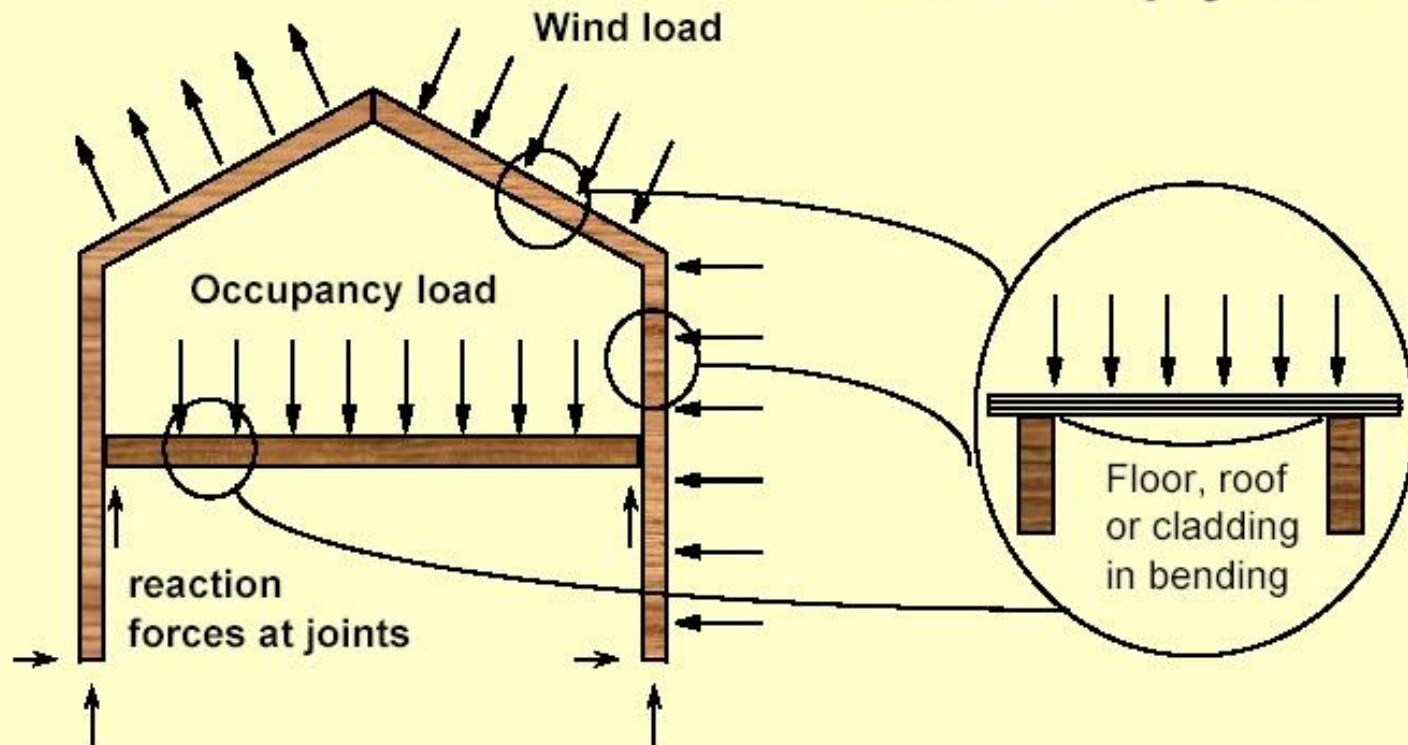
**Randomly select veneer to make 5 ply
- From Cut of Log Veneer**



Or a different random group
from a heart run

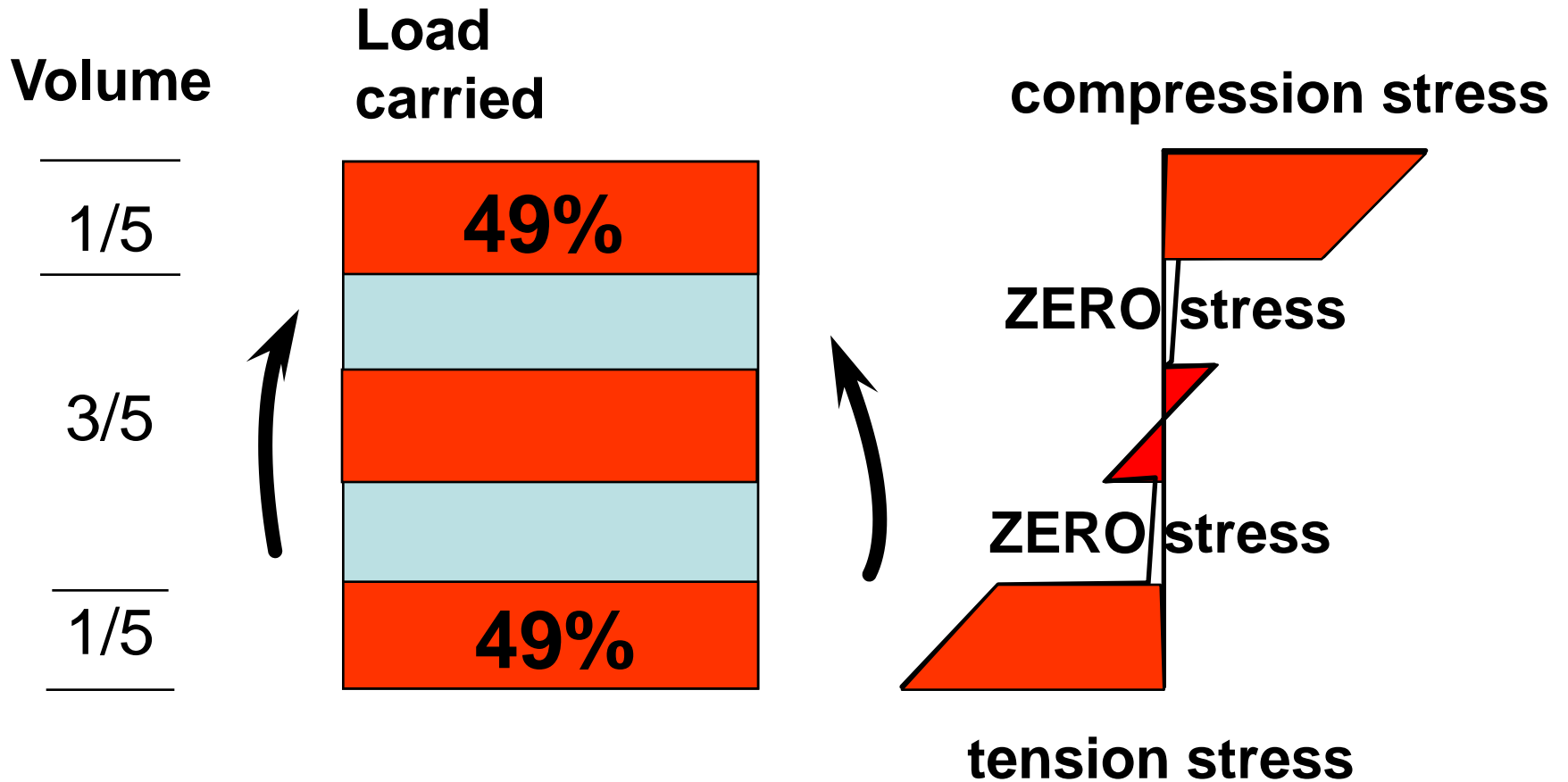


Structural plywood

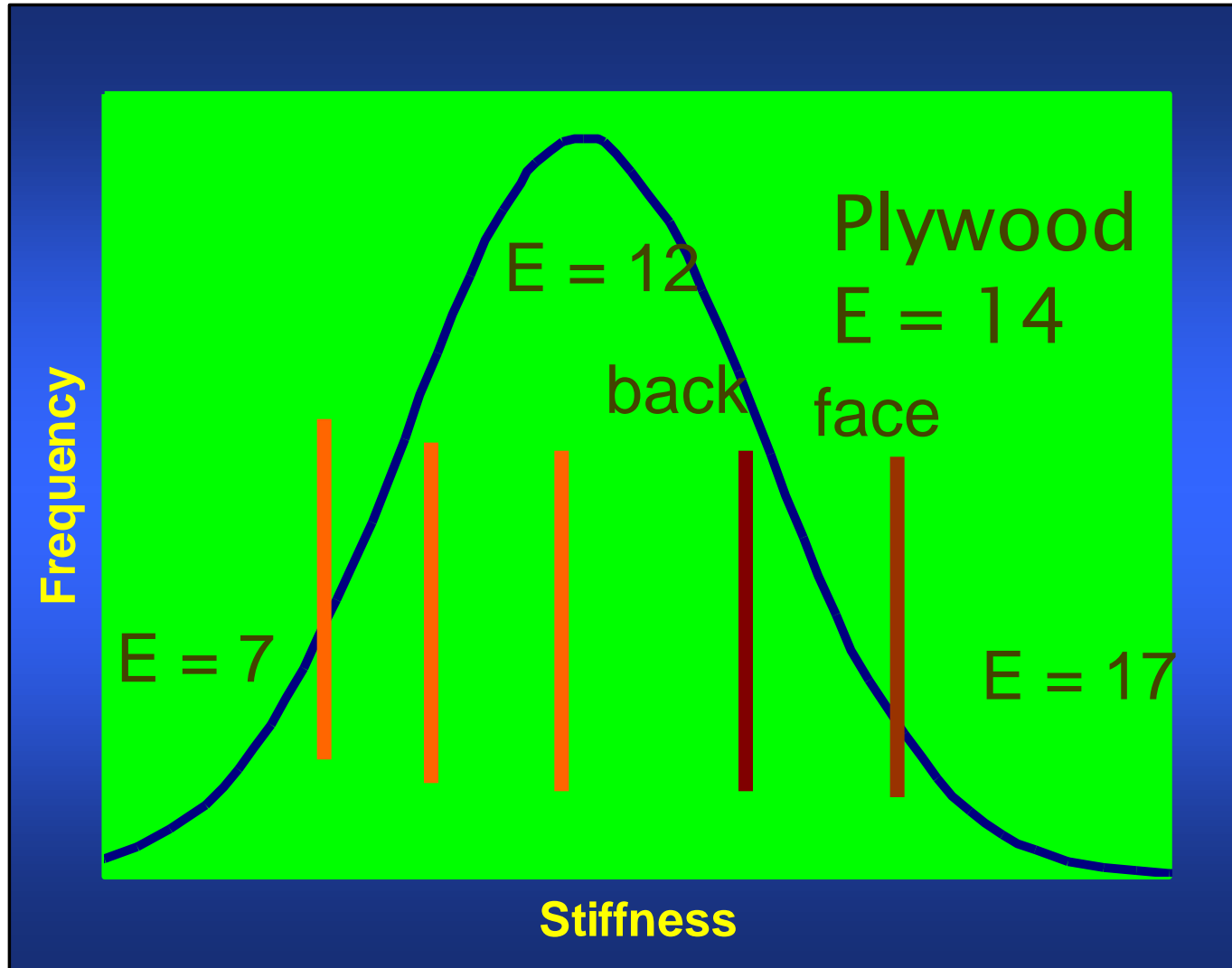


The structural promise: defined, consistent, reliable, load resistance properties.

Bending in 5 ply



Select veneer to make 5 ply - using sonic grader



Summary:

How does it work in the mill?

- **Random cut of log, E = 11**
- **Random heart, E = 7?**
- **Engineered, E graded E = 14**
- **from same resource.**

The pitfalls

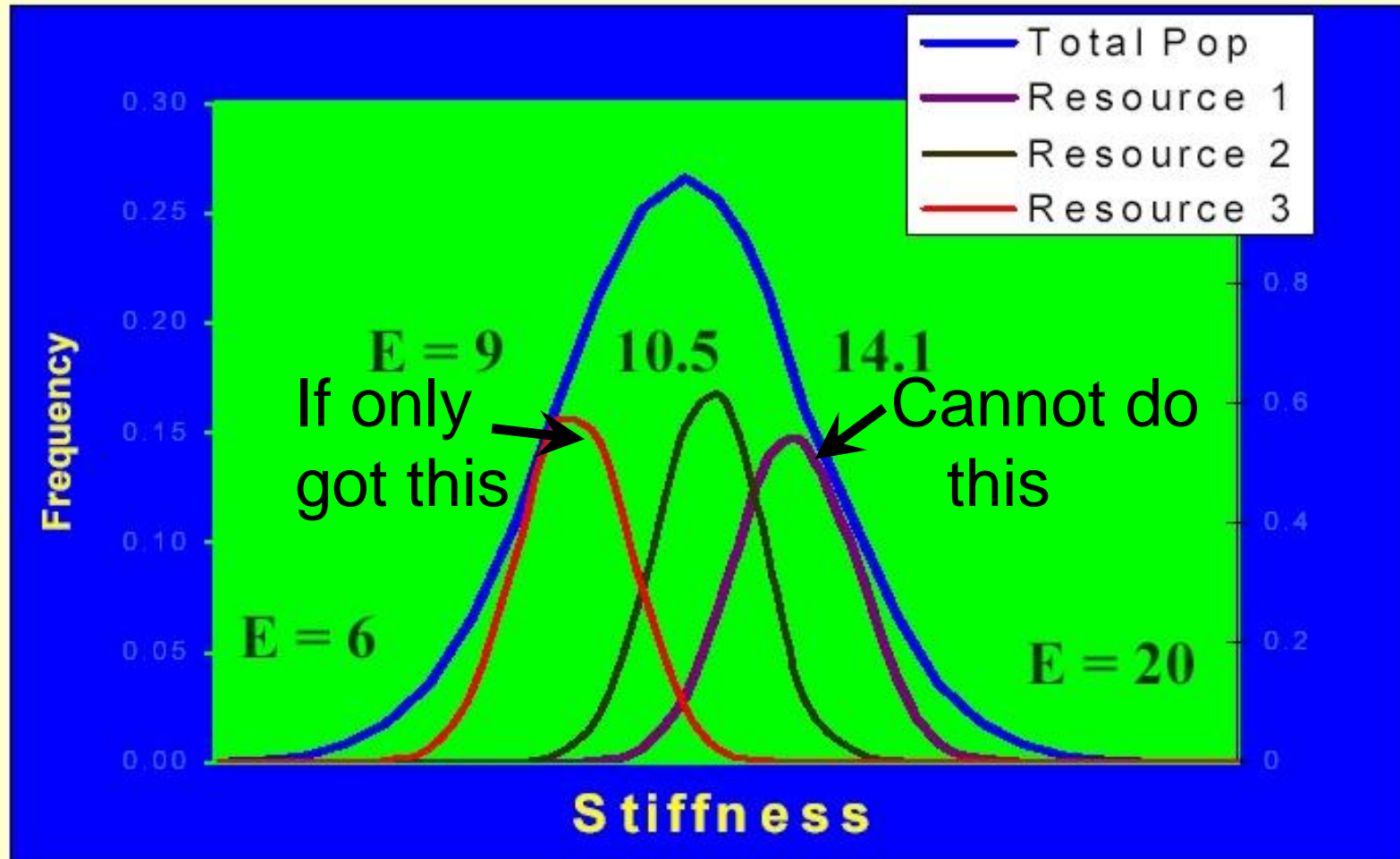
Who done it?
We all do it!!

- Not enough face veneer
- Mixing up inners with faces
- Heart vs sap,
 - settings for different wood resource
- Capital cost

The pitfalls - solutions

- inventory control, operator training
- heart vs sap, different UPT cut offs, feedback and adjustment control loop
- **QUALITY CONTROL**
- Capital cost, do the sums, E grading, better than visual.
- **Balance resource to product mix**

Balance resource to product mix



SORT LOGS before you use them , or better, before you buy them



Sonic Log Selection: HM 200



Sonic Stand evaluation: ST300

Key Strategy – whole carcass

If you grade out high stiffness for a product

- Develop market for complementary lower stiffness

AND/OR

Use lower grade in core (ply or plank).

Other “levers” : - some challenges

- Designers want a span, not a grade
- Span capacity is a product of F grade and Layup
- for deflection, think “EI”
- In Timber F14 is 32% stiffer than F8
- In Plywood F8 can = F14

Snap shot from page 25 Table B1 of AS/NZS 2269

I parallel

15		15-15-7		170
15		15-24-7		205
15		15-30-5		225

- Top **I** x 12GPa = 2040 EI
- Bottom **I** x 9.1GPa = 2048 EI
- Top F14 = Bottom F8 = SAME SPAN CAPACITY

Challenge = Opportunity

- If I have heaps F8 can match F14 span.
- If I make all F14 - 3 mm thick, am I wasting valuable resource.
- F is veneer property, need span property
- Should AS/NZS have span rating, not F rating?

Total optimisation

- Better stiffness control
- Easier structural grading
- Machine, not visual
- Build structural quality in before making panel.
- Clearer messages to designers
- Profit from lower stiffness resource