



Strategic Integrated Research in Timber



introduction to wood properties

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In association with

The Wood Technology Society

A Division of the Institute of Materials, Minerals and Mining

**THE QUEEN'S
ANNIVERSARY PRIZES**
FOR HIGHER AND FURTHER EDUCATION
2015

Extreme Trees

Monuments to nature's possibility, some tree species can go to extremes—from towering canopies shading coastal forests to ancient, gnarled branches casting scant cover over arid landscapes. Many such trees have fallen prey to logging and human encroachment over the years. But a few persist.



Figure for scale

THE RECORDS

HEIGHT

115.6 m

Coast redwood*

Sequoia sempervirens

HEIGHT

99.6 m

Mountain ash

Eucalyptus regnans

DIAMETER

More than **10 m**

Montezuma bald cypress

Taxodium mucronatum

VOLUME (Main trunk)

1,489 m³

Giant sequoia

Sequoiadendron giganteum

AGE

More than **4,800** years old

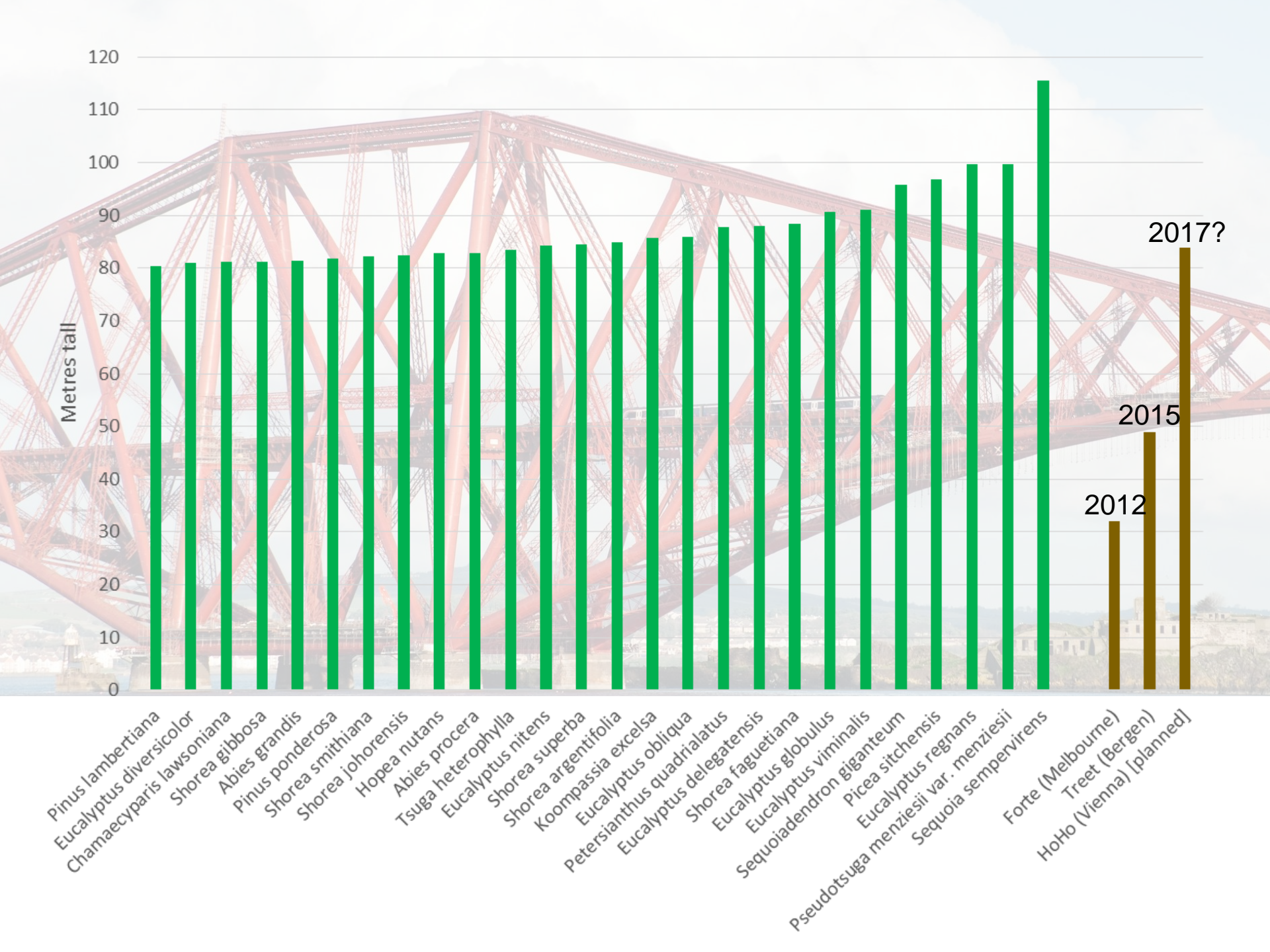
Great Basin bristlecone pine*

Pinus longaeva

9 m (approximate)

9 m (approximate)

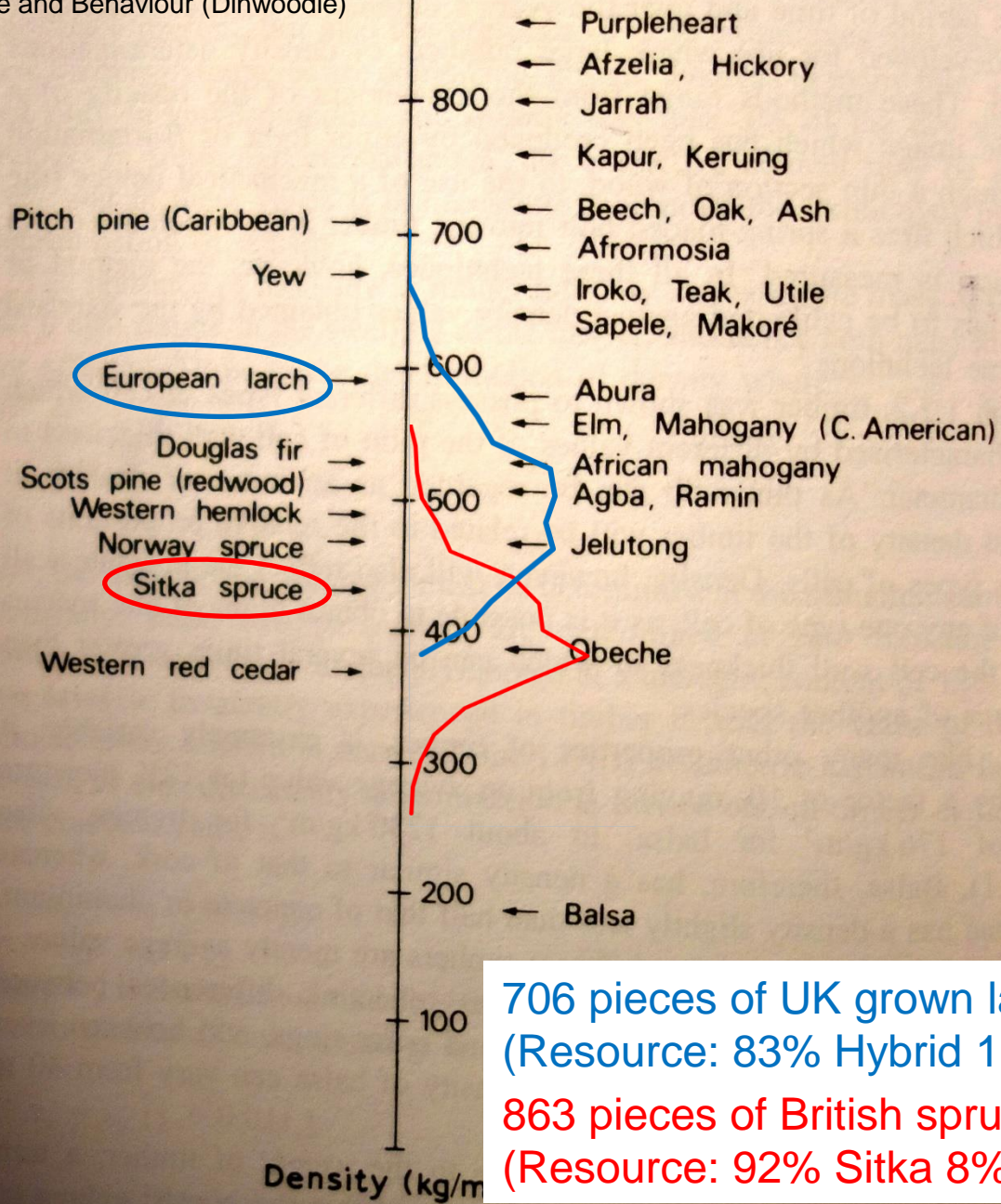
Human for scale



Issues

- Water
- “Figure” and “Defects”
- Anisotropy
- Inhomogeneity
- Variation and uncertainty





706 pieces of UK grown larch
(Resource: 83% Hybrid 17% European)

863 pieces of British spruce
(Resource: 92% Sitka 8% Norway)

Figure 3.1 Mean density values at 12% moisture content for some common hardwoods and softwoods (© BRE.)

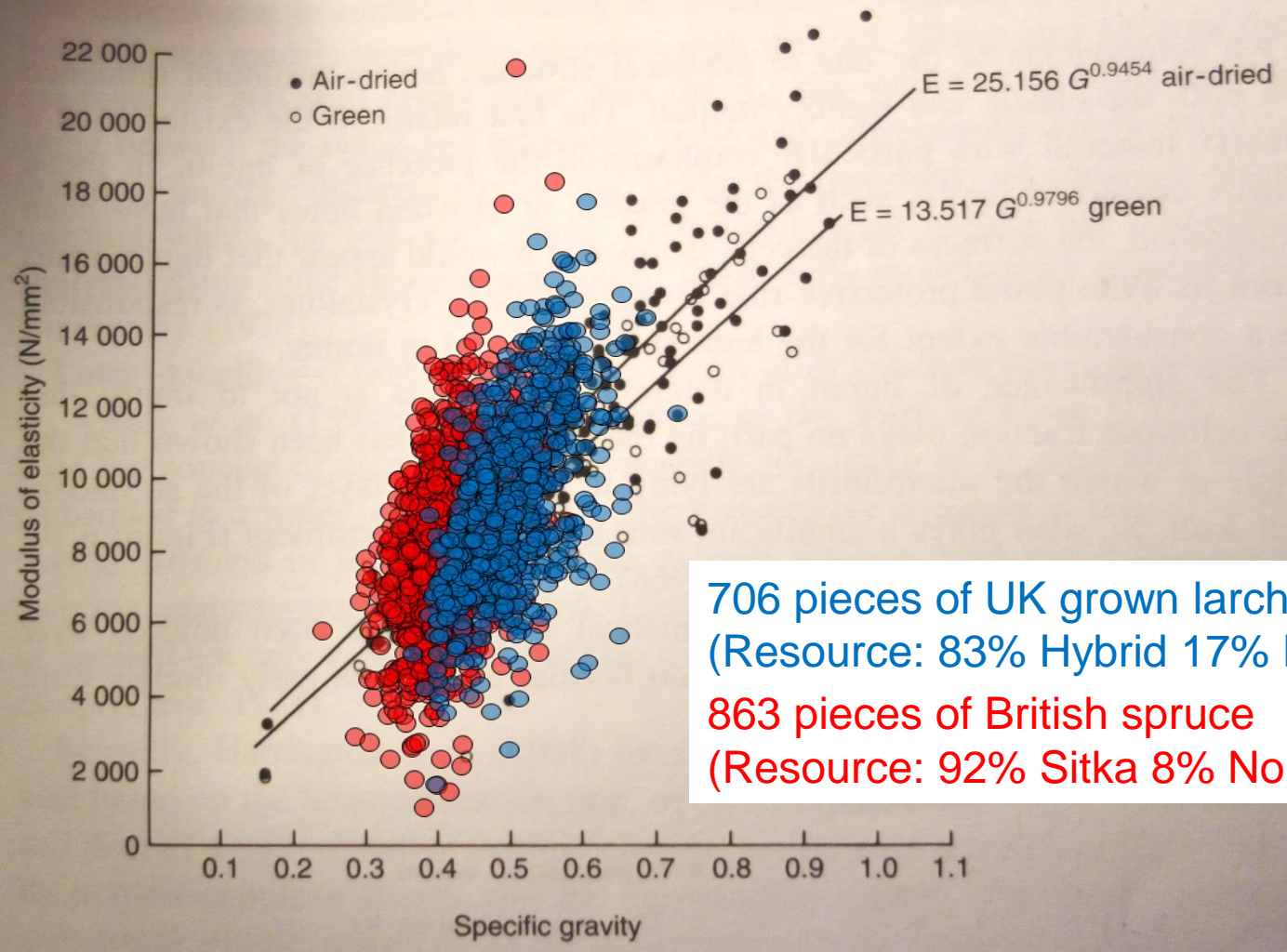
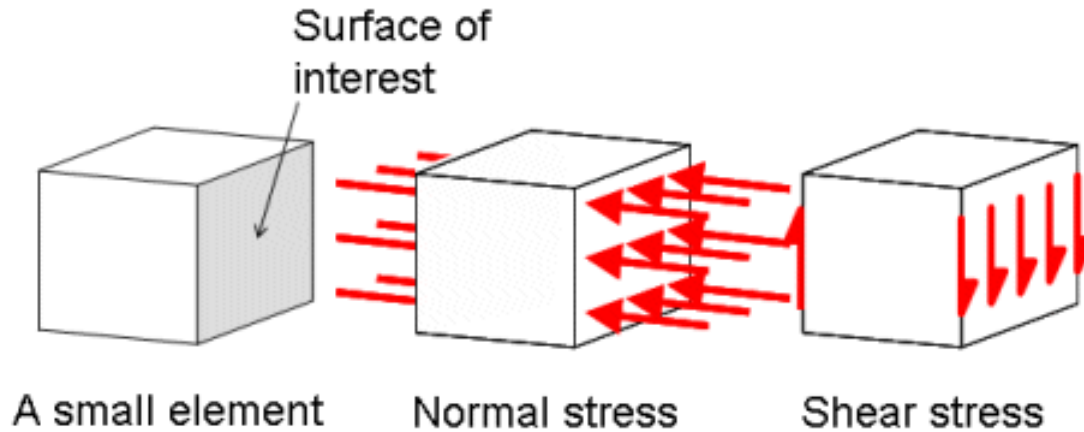
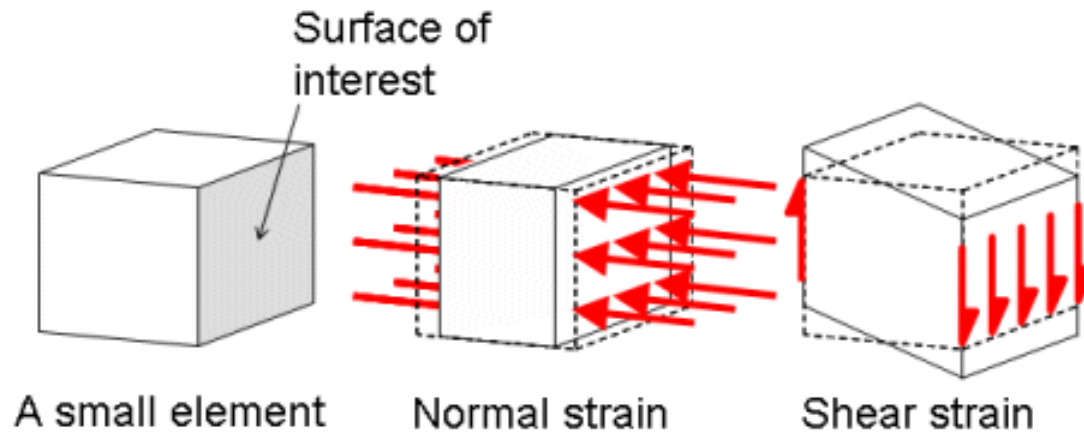


Figure 6.9 Effect of specific gravity on the longitudinal modulus of elasticity for over 200 species of timber tested in the green and dry states. (© BRE)

Stress and strain



$$\frac{\text{Force}}{\text{Area}}$$

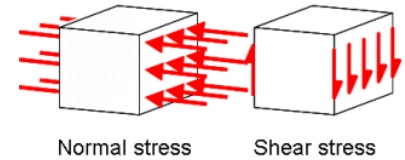


$$\frac{\text{Change in dimension}}{\text{Original dimension}}$$

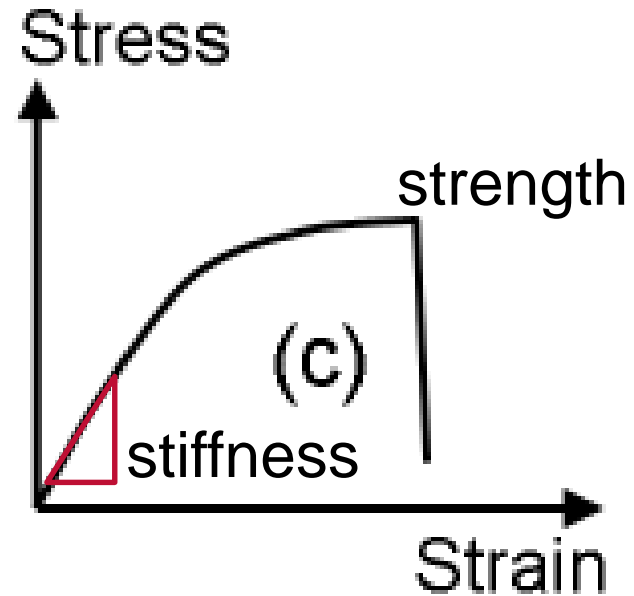
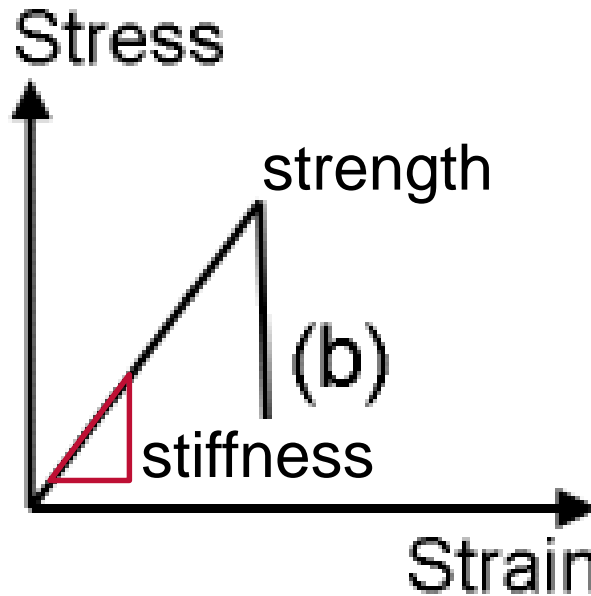
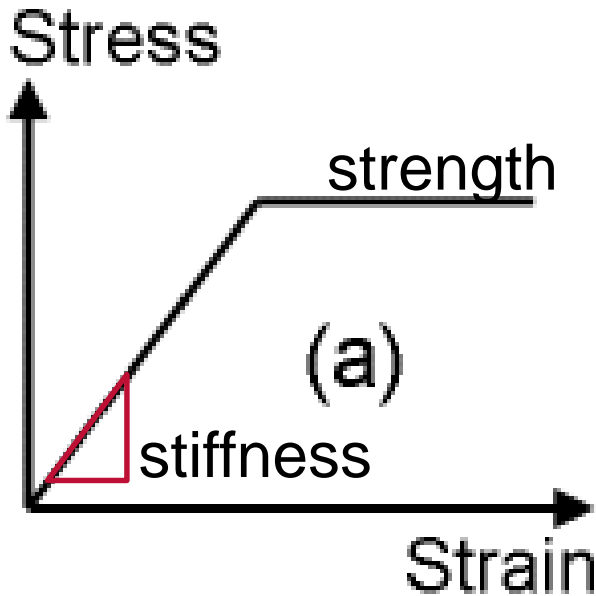
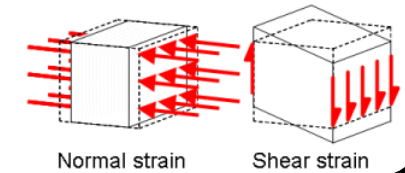


Stiffness and strength

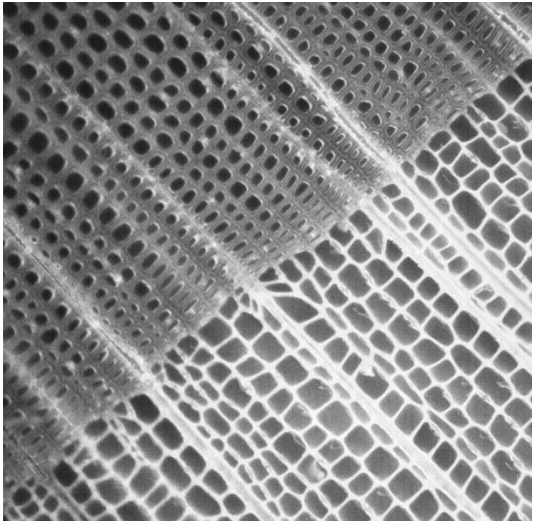
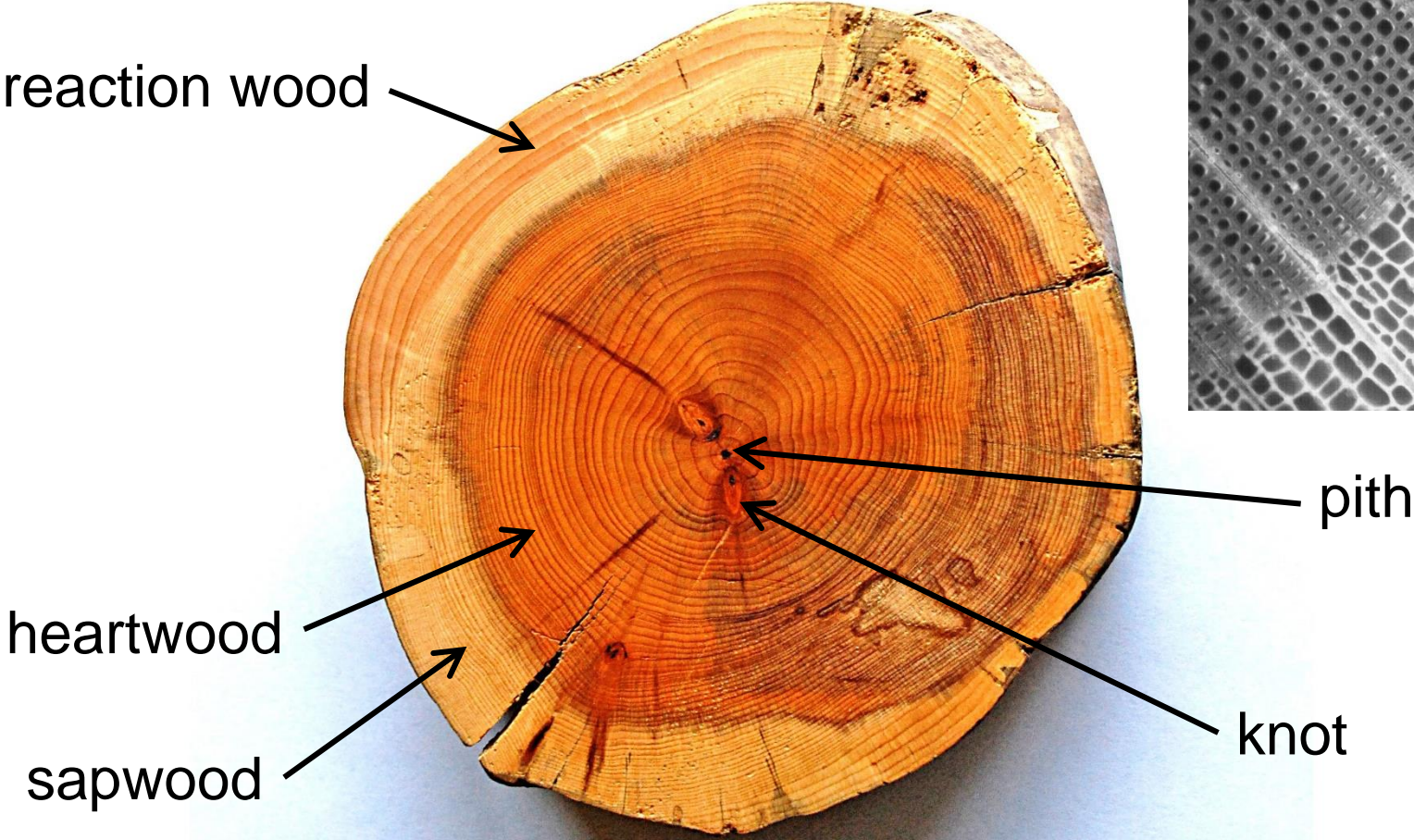
Strength (tensile, compressive, bending)
Stiffness (modulus of elasticity, MoE) = E

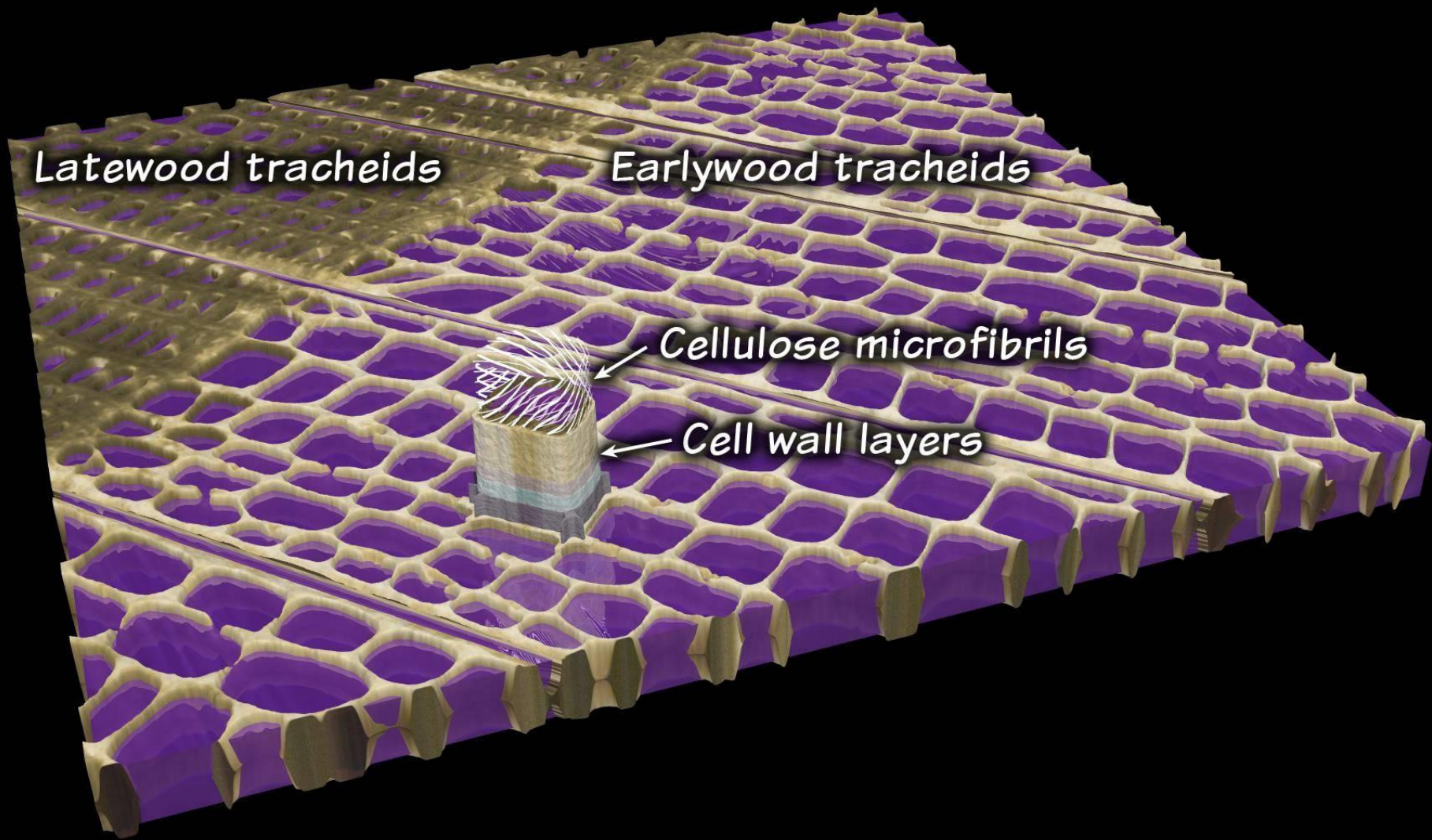


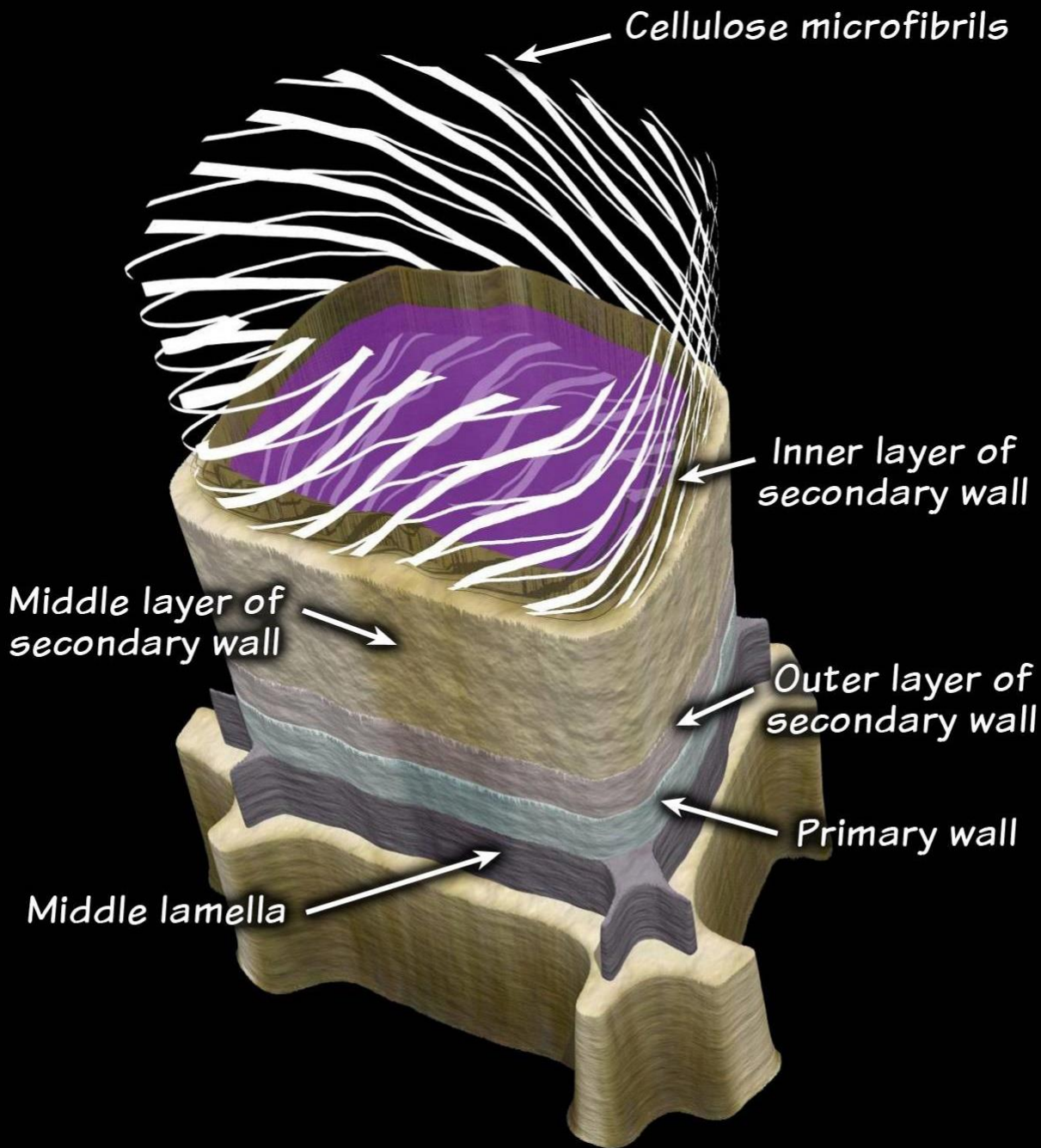
Shear strength
Shear modulus = G



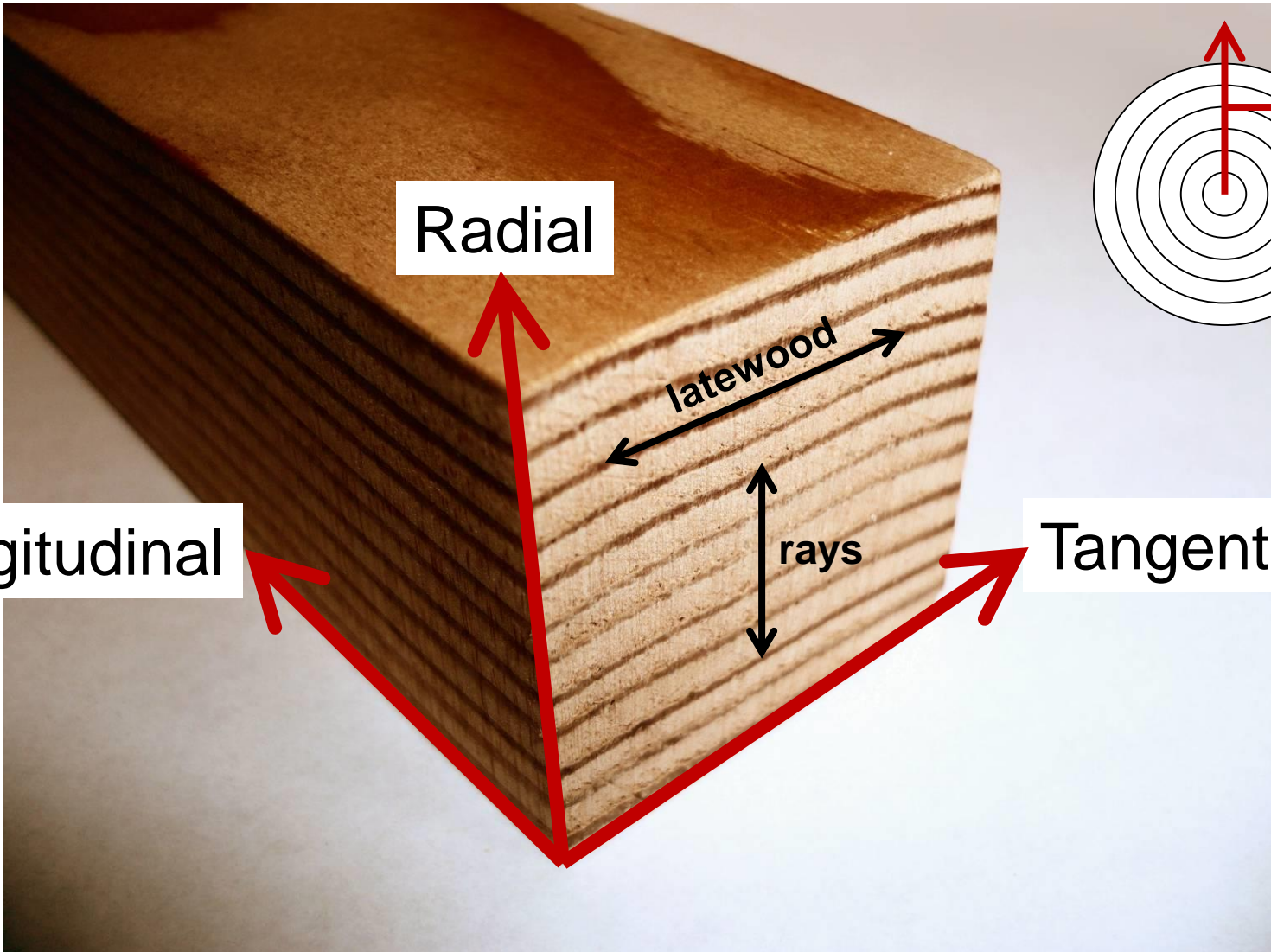
Anatomy







Isotropy



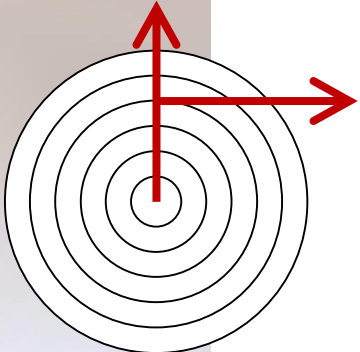
Radial

Longitudinal

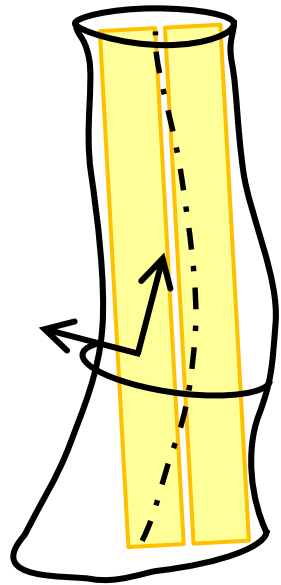
Tangential

latewood

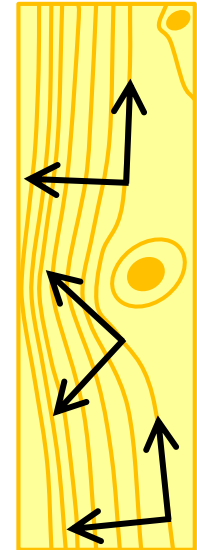
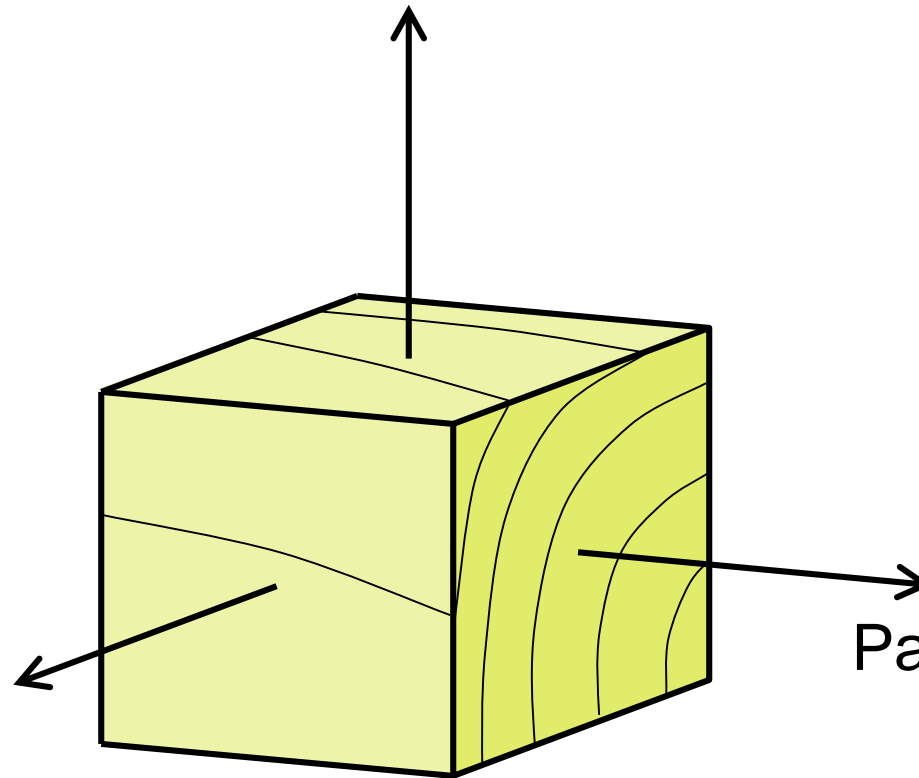
rays



Directions



Perpendicular to grain

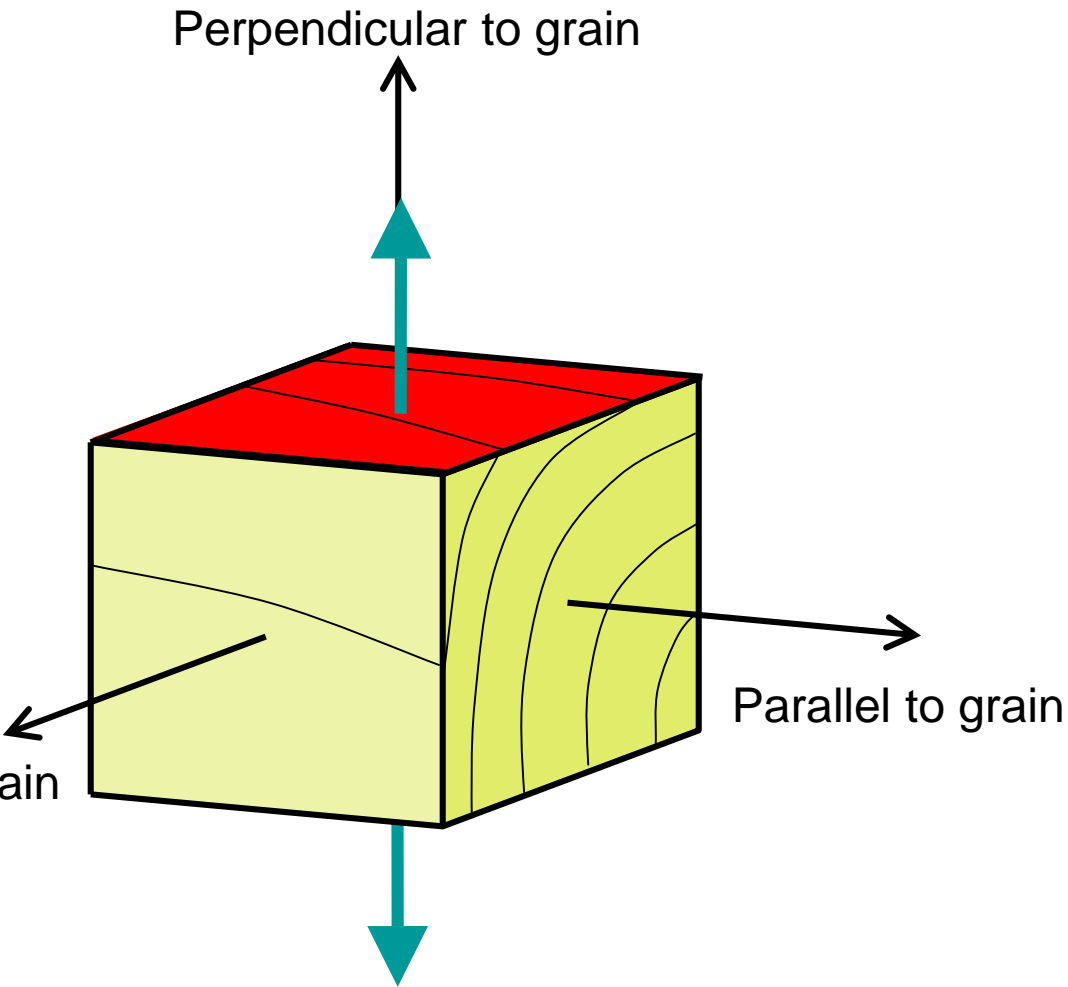
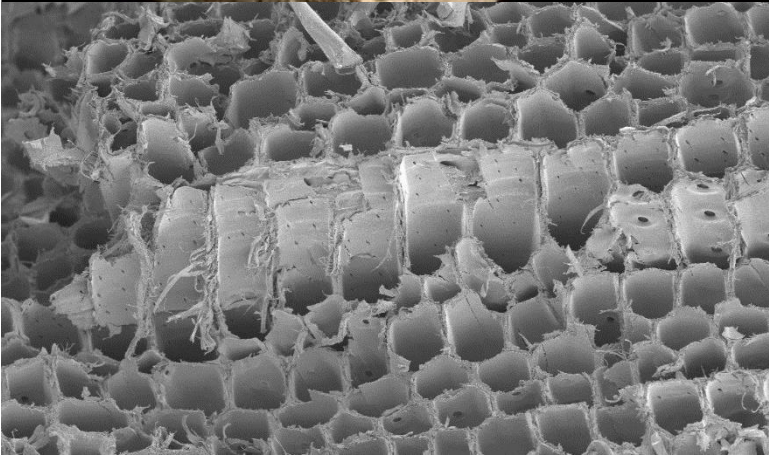


Parallel to grain

Perpendicular
to grain

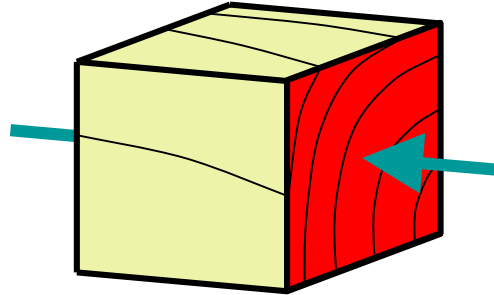


Compression and tension



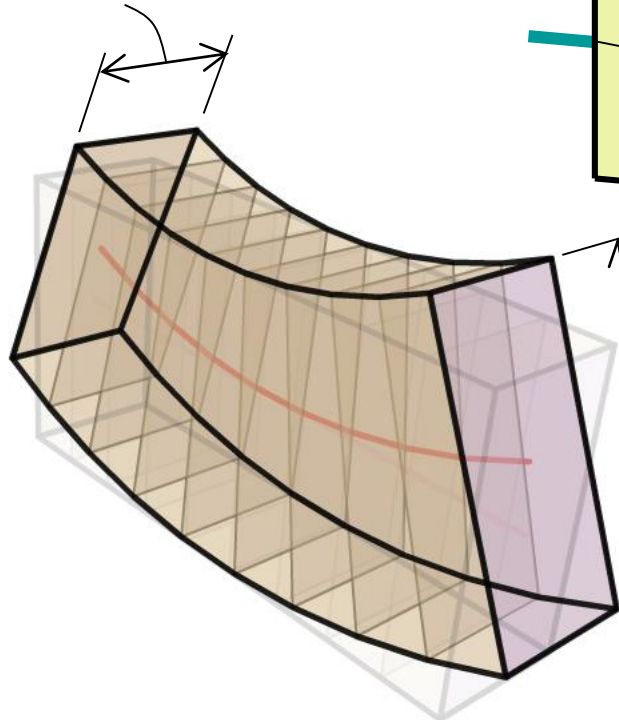
Bending

Compression



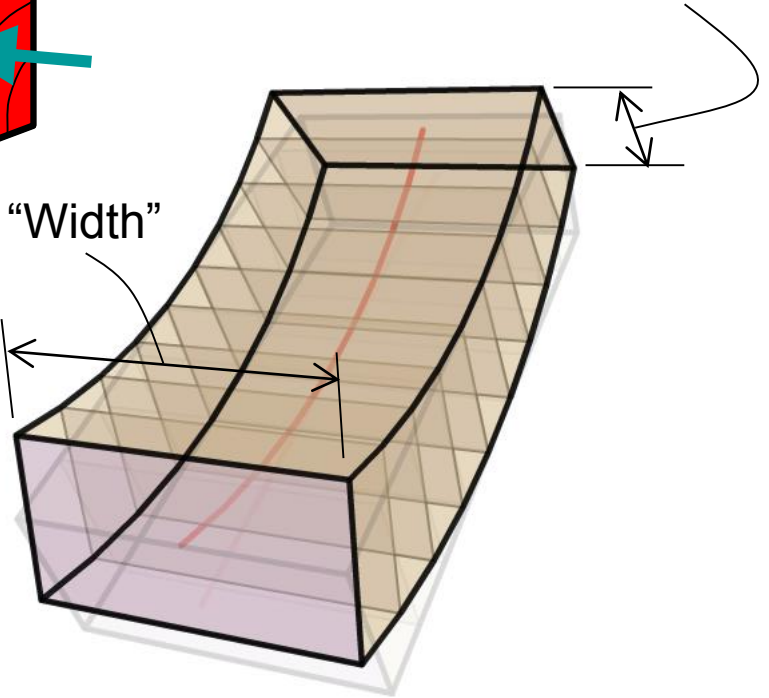
“Thickness”
is the “Depth”

“Thickness”

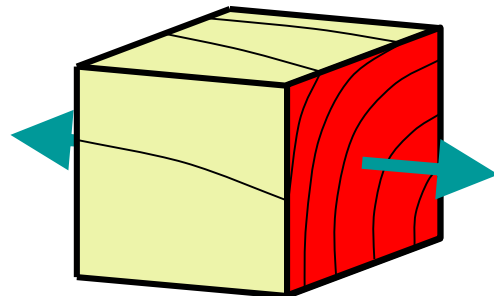


“Width” is
the “Depth”

“Width”



Tension

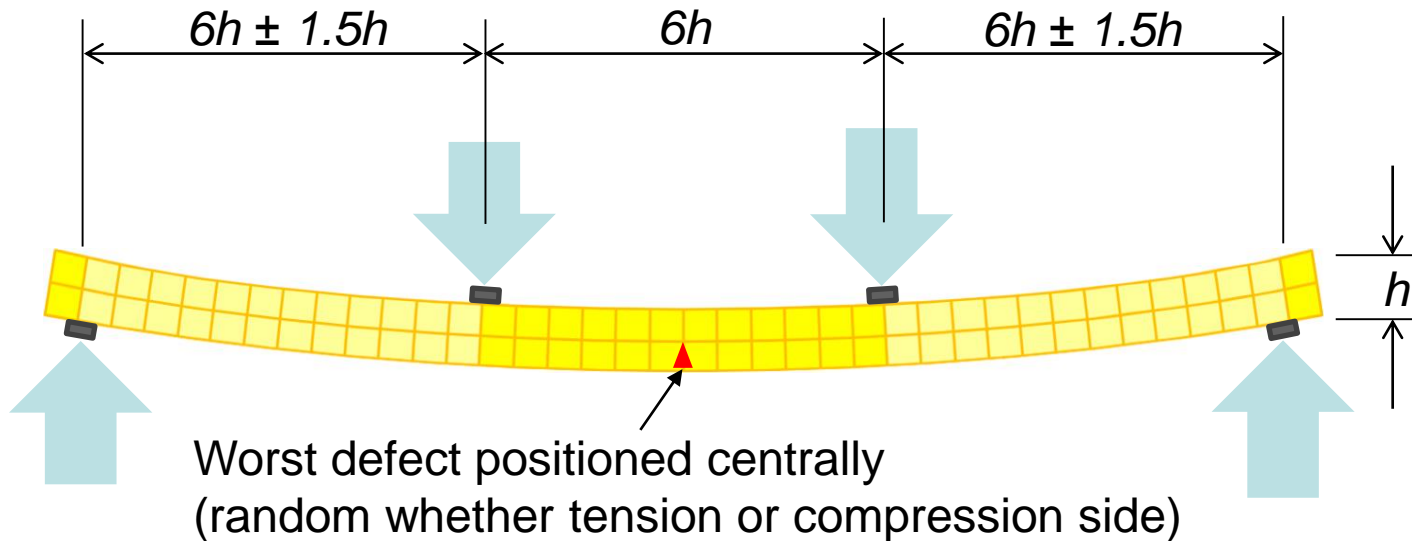


Major axis
(as a joist)

Minor axis
(as a board)

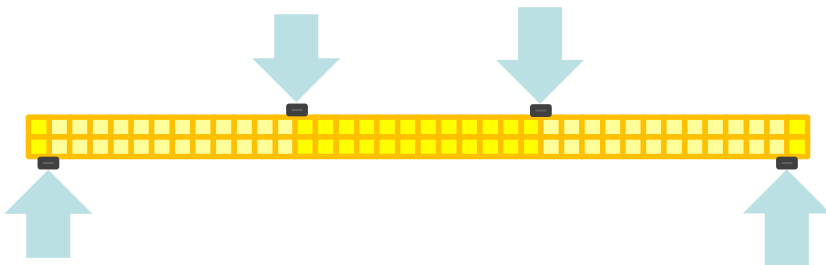
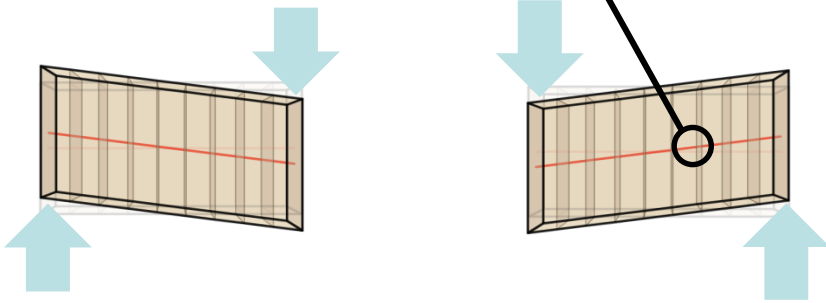
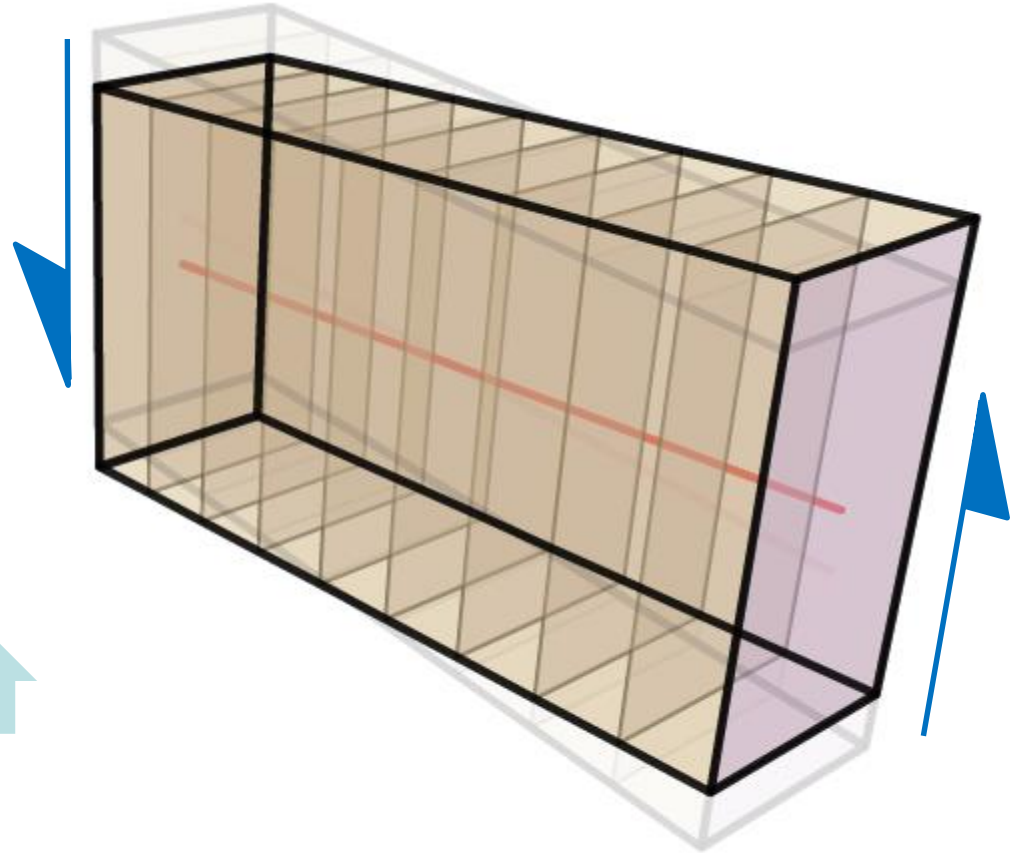
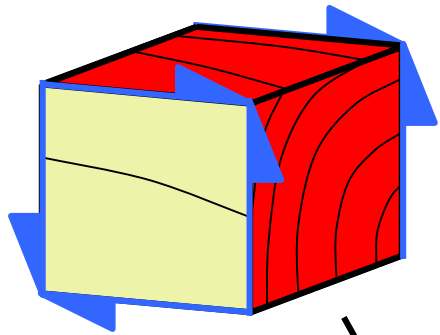


EN408 bending test



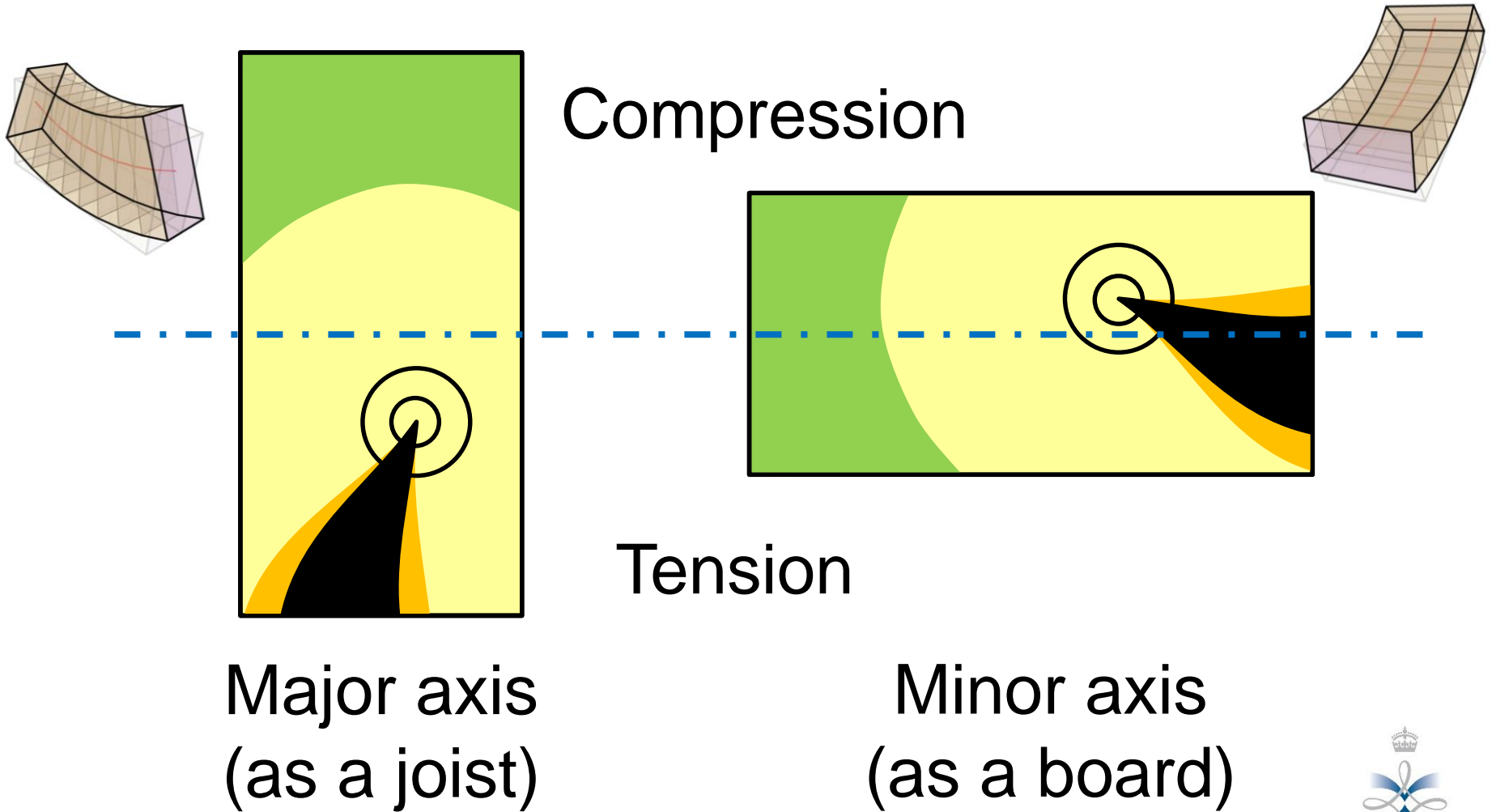
Bending strength, f_m (Modulus of Rupture MoR)
Stiffness, E (Modulus of Elasticity MoE)

Shear

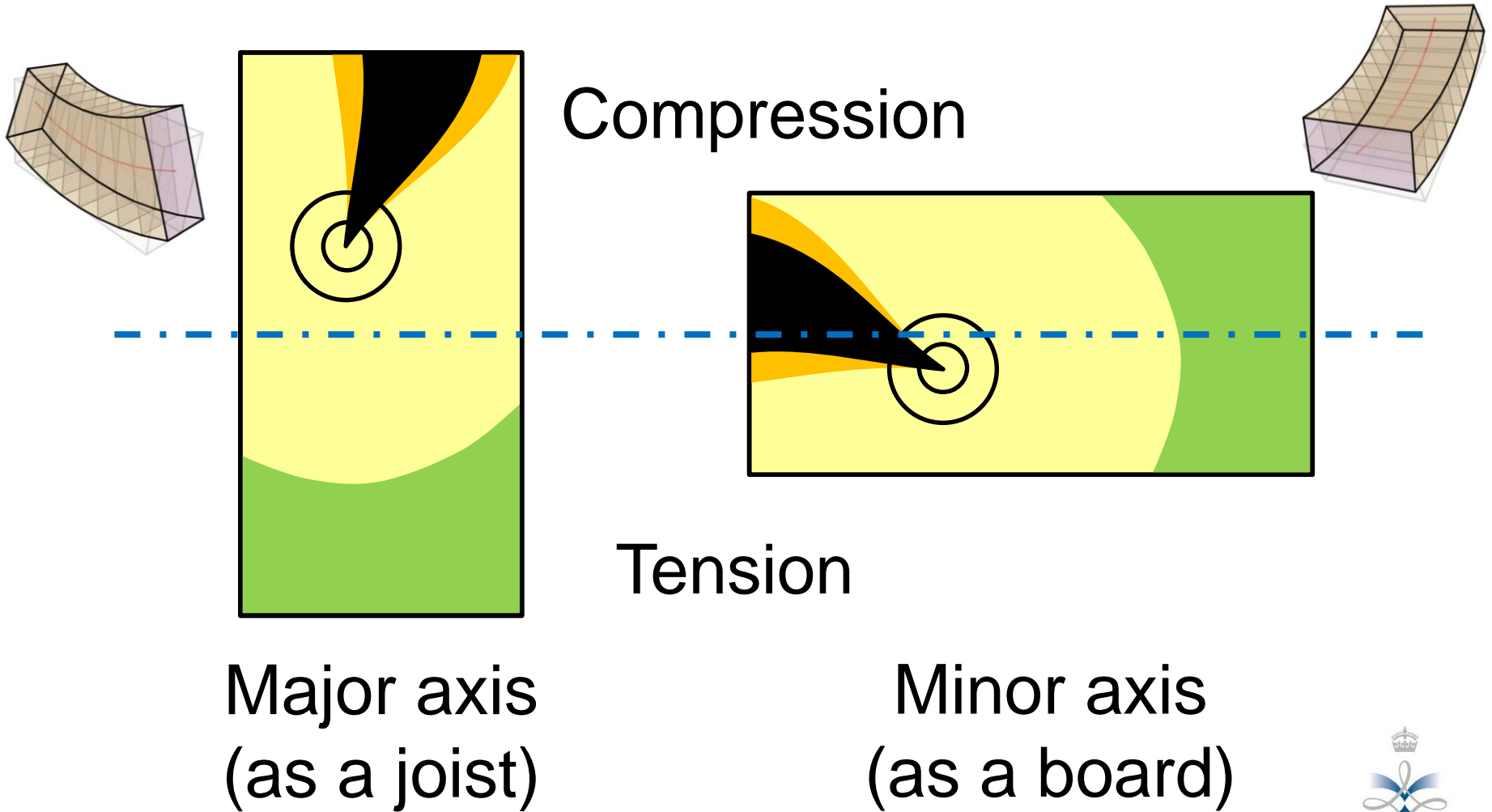


Shear modulus, G

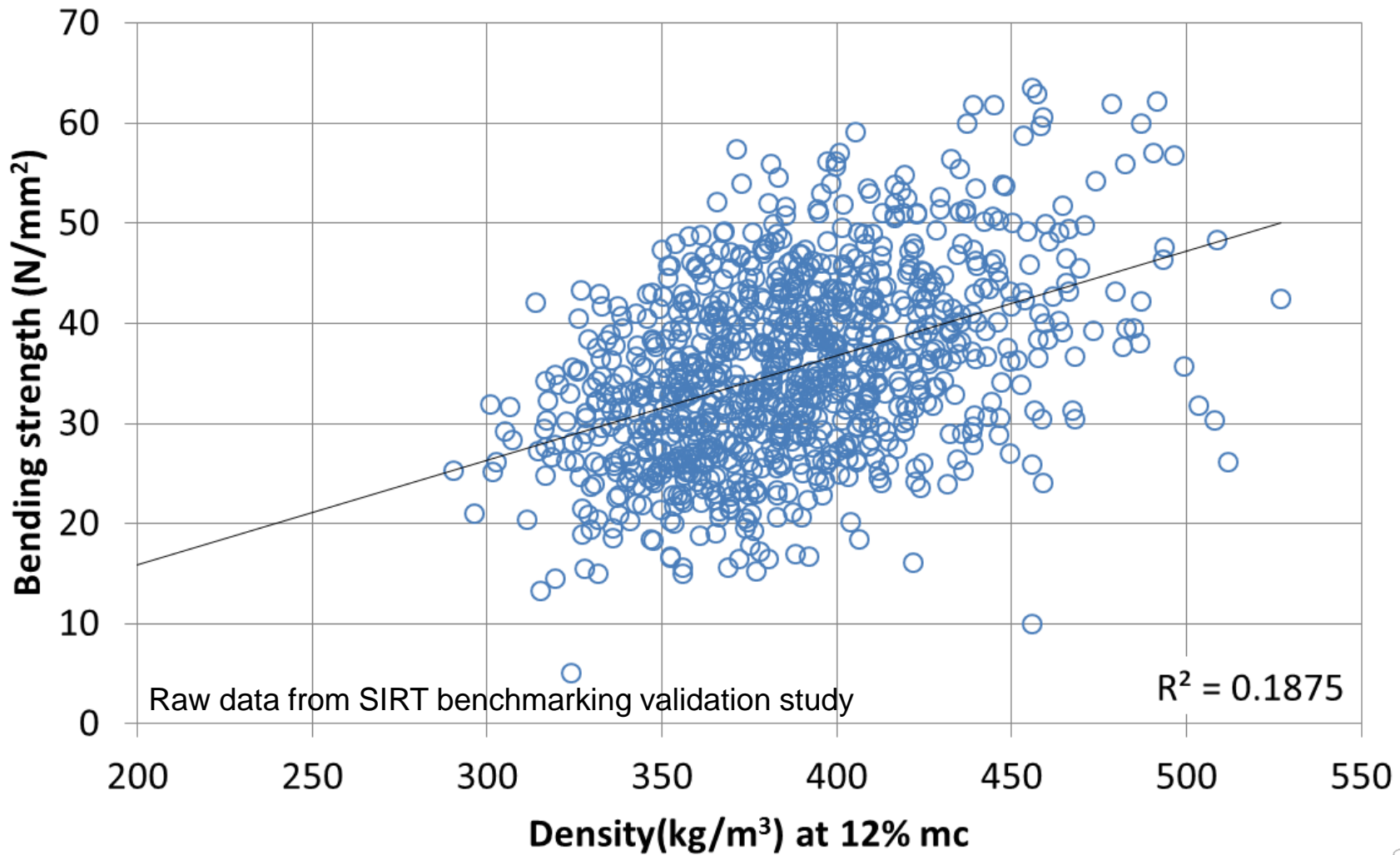
Bending



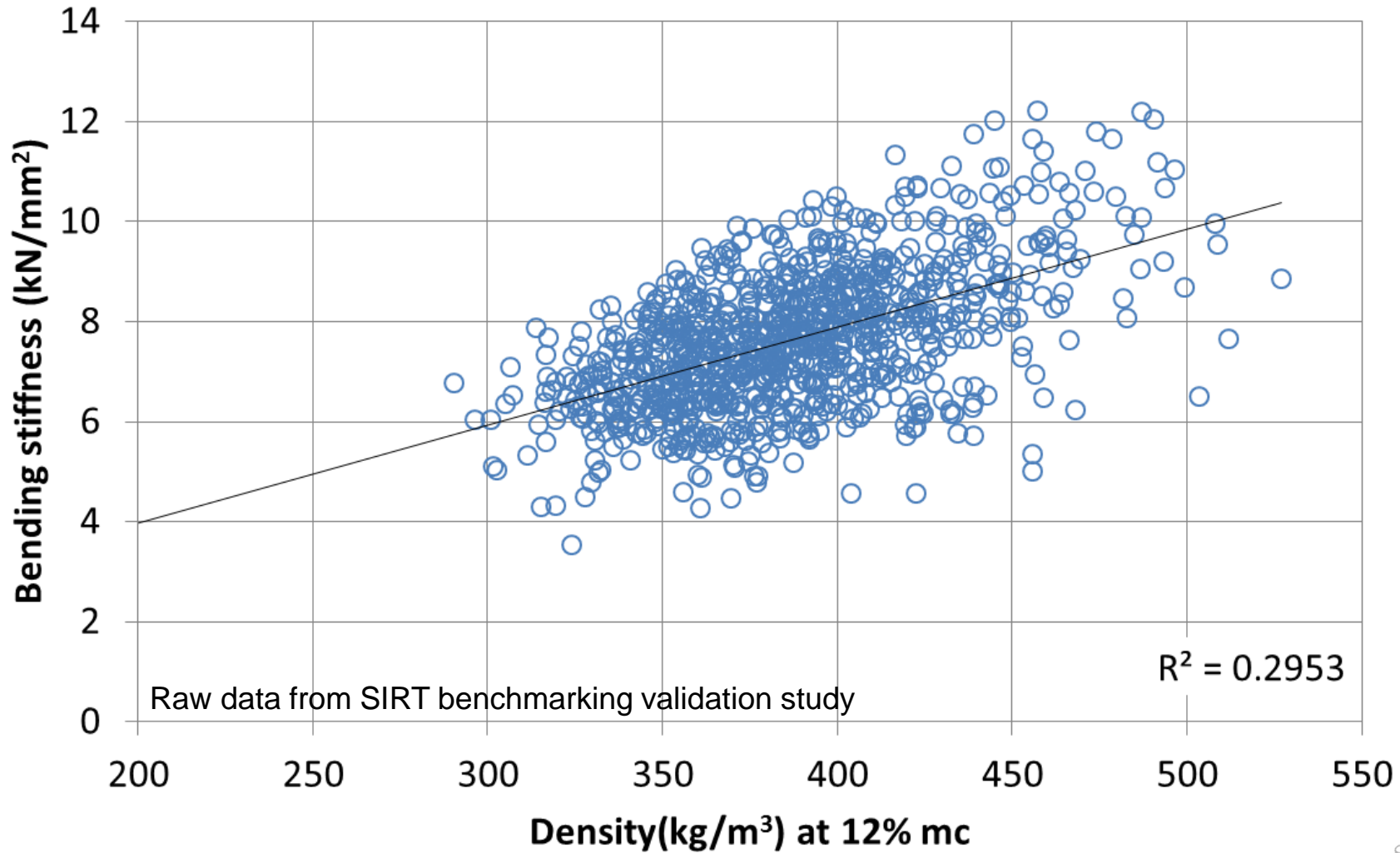
Bending



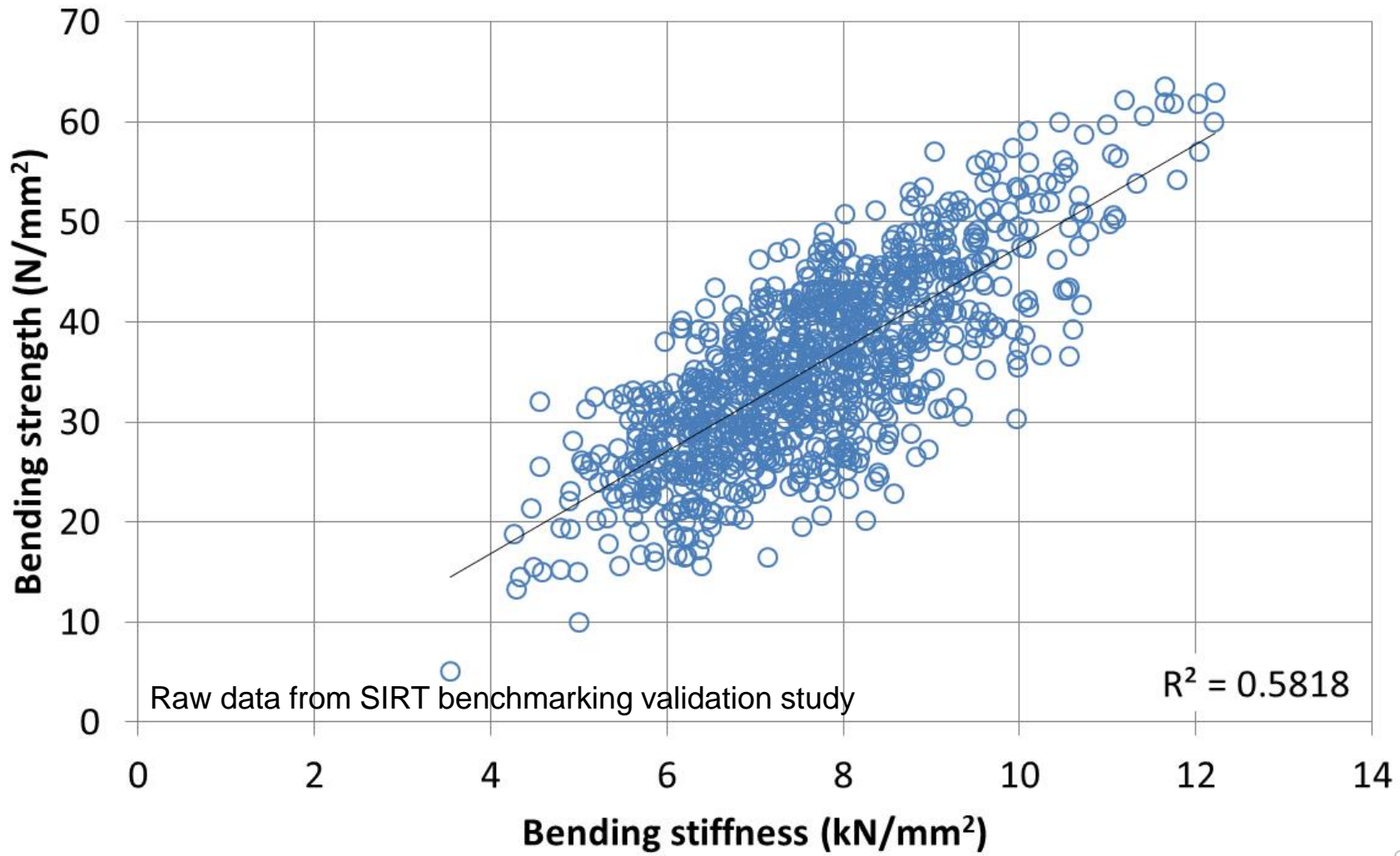
Density and bending strength



Bending strength and stiffness



Density and bending strength



Mechanical properties

- Amount of cell wall material
 - Wood density
- How that cell wall material is arranged
 - Grain, earlywood, latewood
- How that cell wall material is made up
 - Cellulose : lignin
 - Microfibril angle



Juvenile core (softwoods)

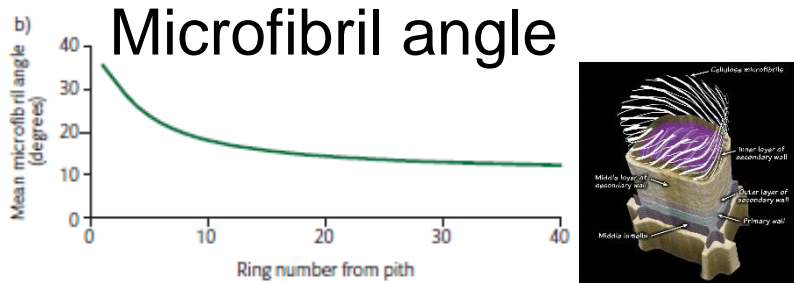
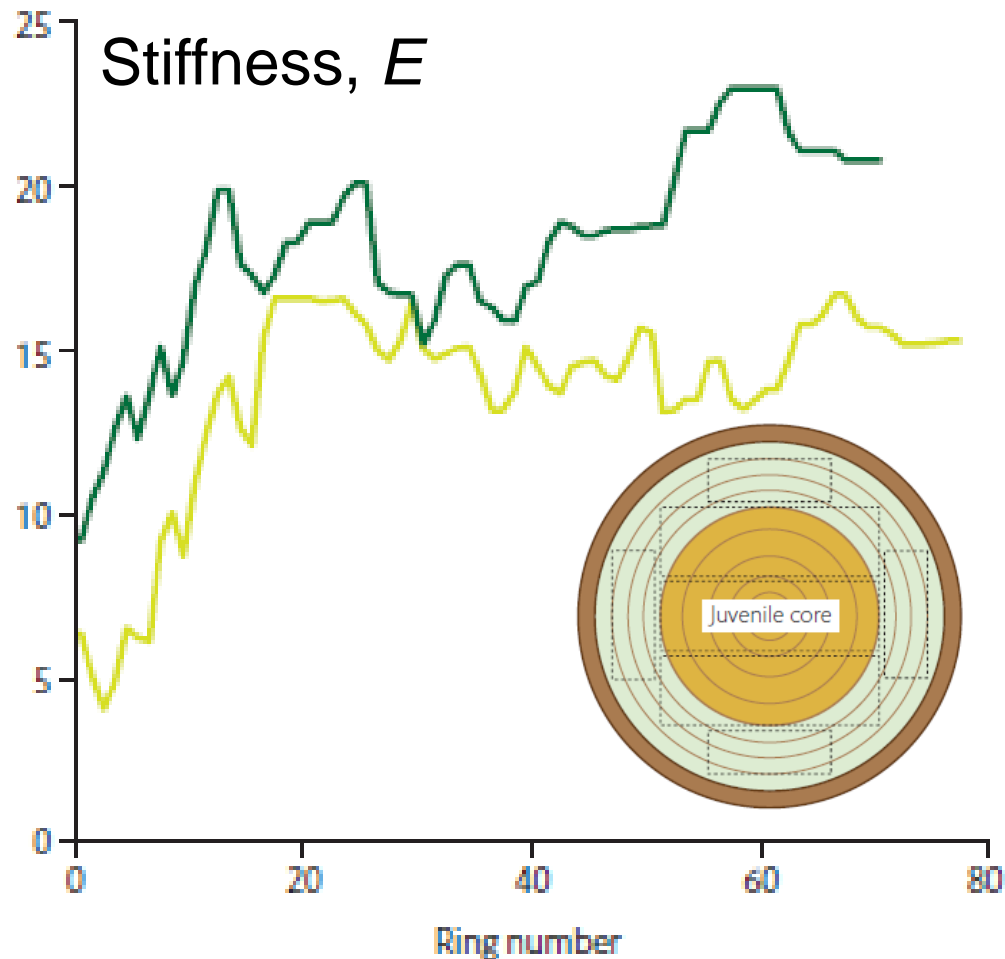
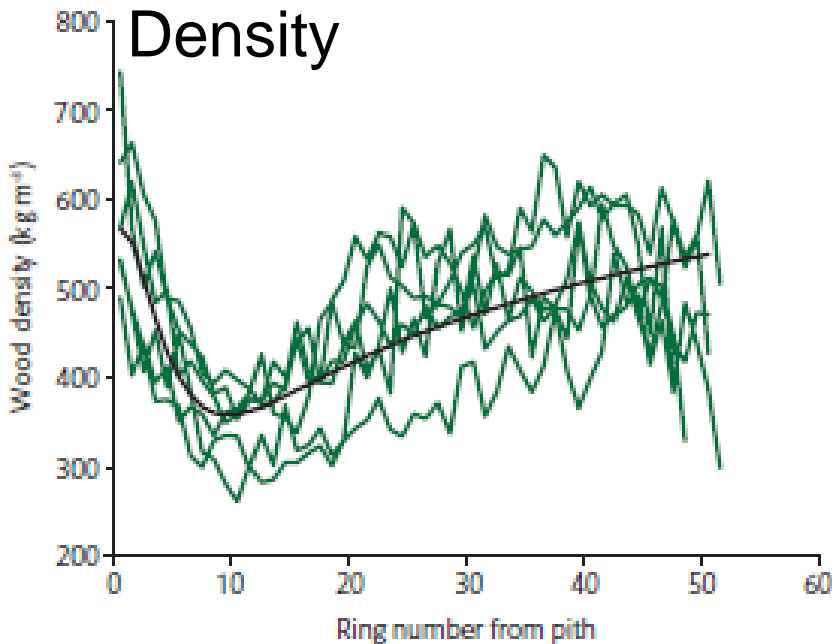


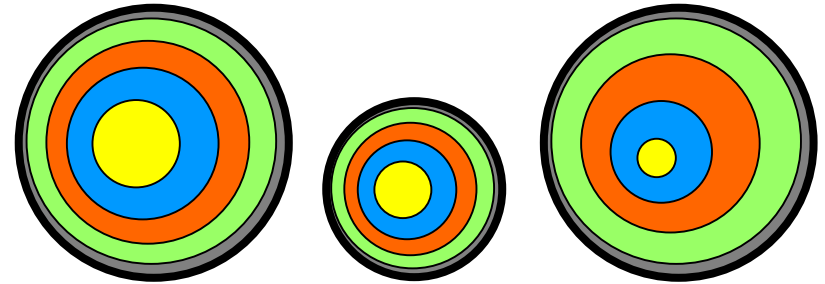
Figure 2.20 Example of the radial variation in modulus of elasticity for two specimens of Sitka spruce wood. Modulus of elasticity was estimated from data on density and microfibril angle obtained from SilviScan-3.

Figure 2.15 Radial profile of Sitka spruce wood density. The green lines show profiles for five individual trees sampled at Baronscourt in Northern Ireland, while the black line represents a model fitted to these data.



Factors → softwood quality

- Position within the tree
 - Radially & vertically
- Silviculture
 - Spacing, thinning, rotation length etc
- Site
 - Exposure, temperature, rainfall, soil type etc
- Genetics
 - Species, variety and individual



Variation

- From species to species
- Within species / species group
 - Between countries
 - Within countries
 - Within a forest
 - Within a stand
 - Between trees in a stand
 - Within a tree
 - Within a board
 - Depending on how the board is loaded

Variation of properties
& correlation between
properties

