# The effects of drying on the dimensional stability of spruce wood


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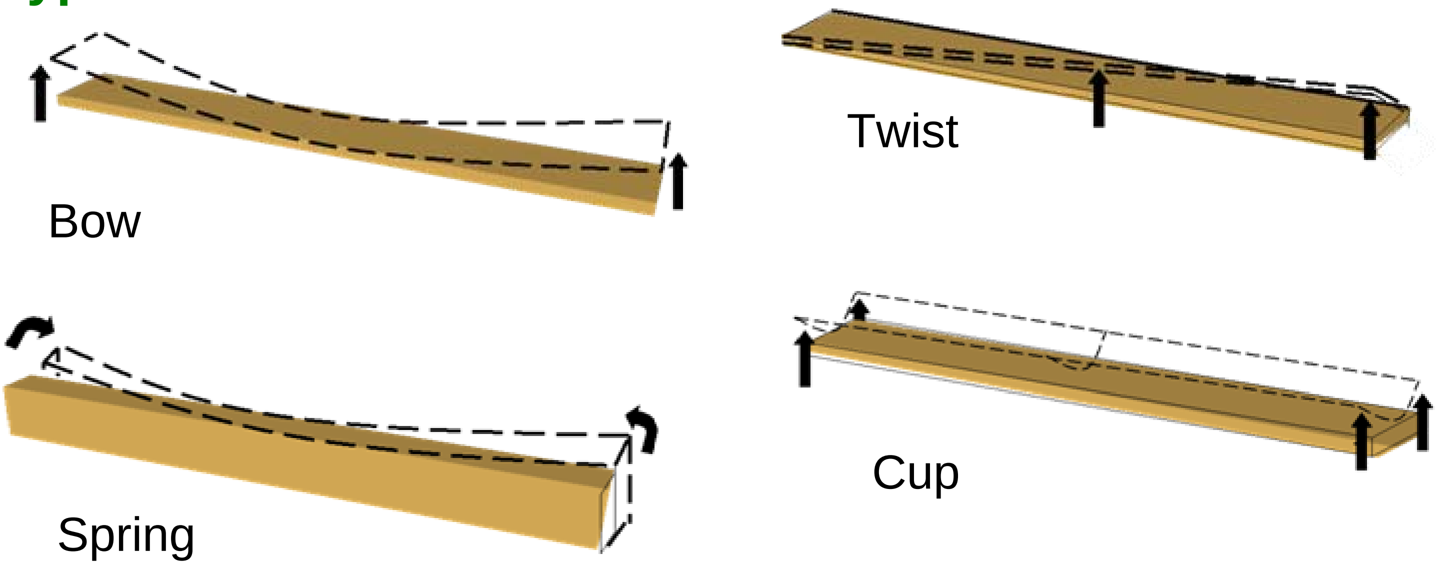
# Problem of distortion

## 4 main types of distortion




**One or all forms may occur in any individual piece of cut timber**

**Twist is considered the biggest problem for construction grade timber**

# Some known causes of distortion

Kiln drying

Juvenile wood

Spiral grain

Anisotropic (uneven) shrinkage

Earlywood / latewood ratio

Reaction/compression wood

Wood density

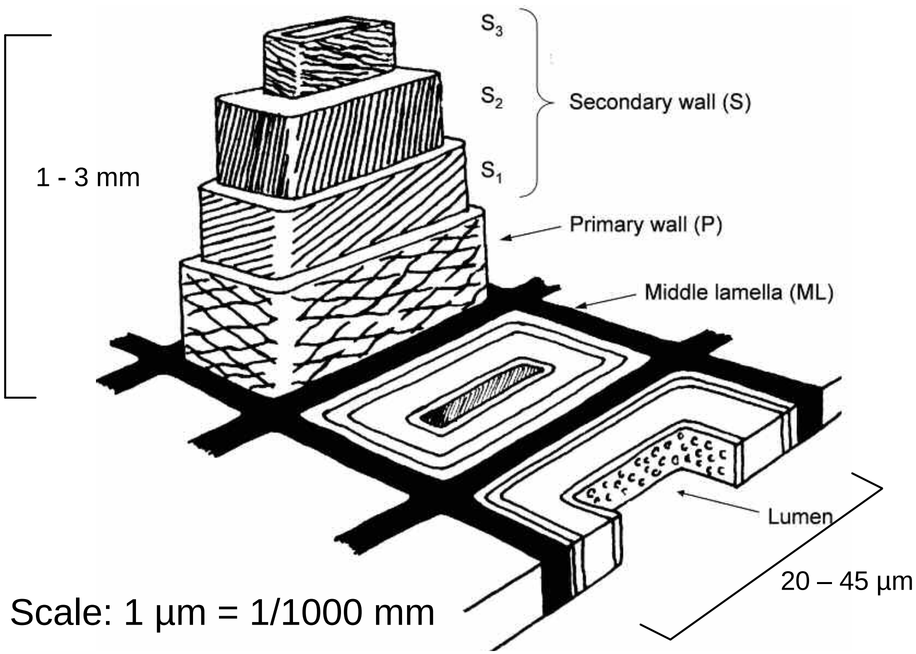
Moisture gradients

Tension release

In service shrinkage/swelling

**Investigation at the cellular level is required to develop our understanding of these processes.**

# Wood anatomy

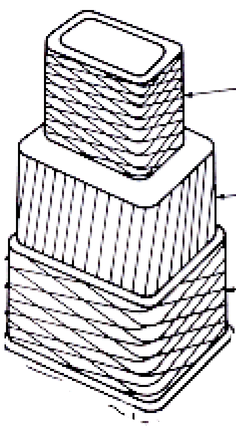



**As cut timber dries "free water" is lost from the cell lumen.**

**The remaining moisture content is bound within the cell walls. Generally this amounts to around 30% moisture content and is referred to as The fibre saturation point (FSP).**

**The greatest influence on shrinking and swelling behaviour is attributed to the S2 layer.**
**This is due in part to the different orientation of the microfibrils in the S2 layer.**

# Microfibril angle (MFA)



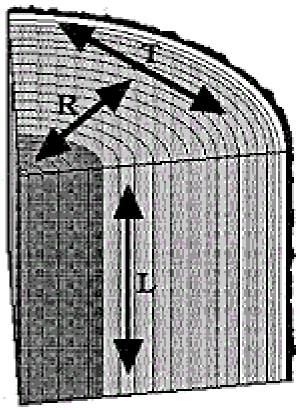

**MFA can vary between species, within species and within individual trees.**

**Juvenile wood commonly has high MFA. As a tree matures MFA decreases in the outer growth rings.**

**How microfibrils are laid down during growth is still poorly understood.**

# Anisotropic shrinkage

**Wood does not shrink evenly in all directions**




**R = radial**
**T = tangential**
**L = longitudinal**

**Below the FSP distortion will occur due to water loss.**

**In addition to changes in MFA, dehydration will also affect cell wall thickness**

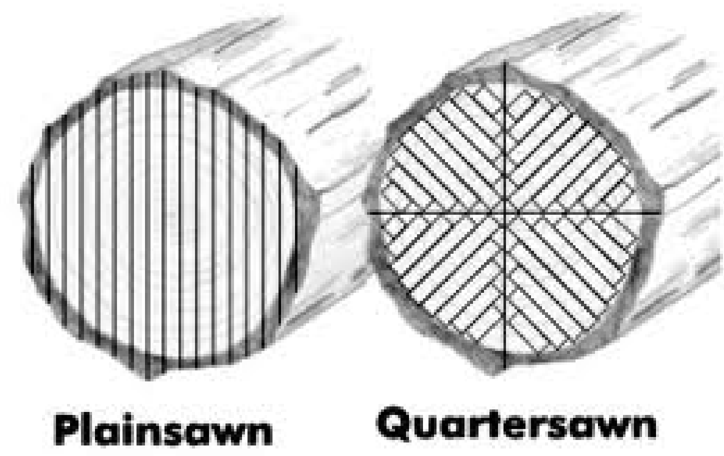
**Previous studies have shown that tangential shrinkage is generally around 1.5 - 2 times greater than radial shrinkage.**

**The reasons for this are still not fully understood.**

# Tangential vs radial shrinkage

Most timber is plain sawn as there is less Wastage and is more economical in terms of cost for the consumer

This involves a high percentage of cuts across the tangential plane.




When sawing at a tangent to the annual rings, the cell configuration is less ordered than that of a cut across the radial plane.

It can be assumed that the tensions released across this plane are more variable than those in the radial plane for the same reason.

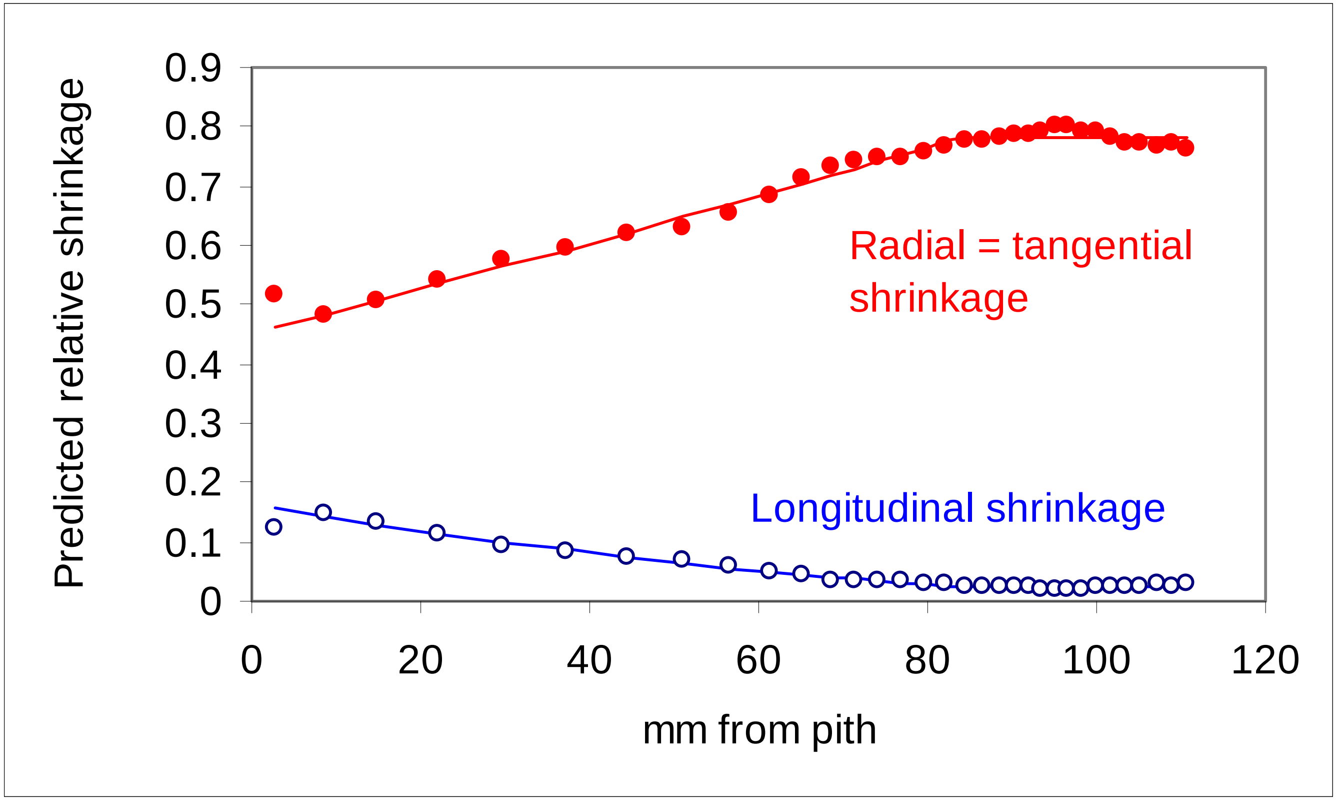
# Two possible mechanisms

(1) An increase in shrinkage, in both radial and tangential directions, with distance from the centre of the disc, consistent with decreasing microfibril angle (MFA)

(2) Greater shrinkage in the tangential than in the radial direction throughout the disc.

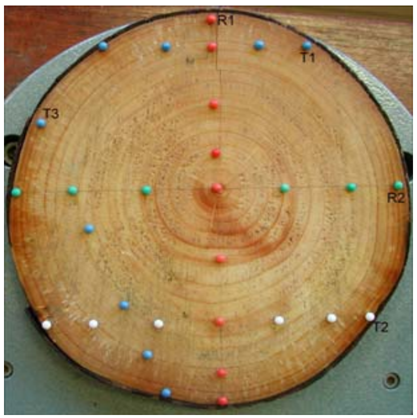
Microfibril angle or its effect on shrinkage must differ between the radial and tangential planes for this mechanism to operate

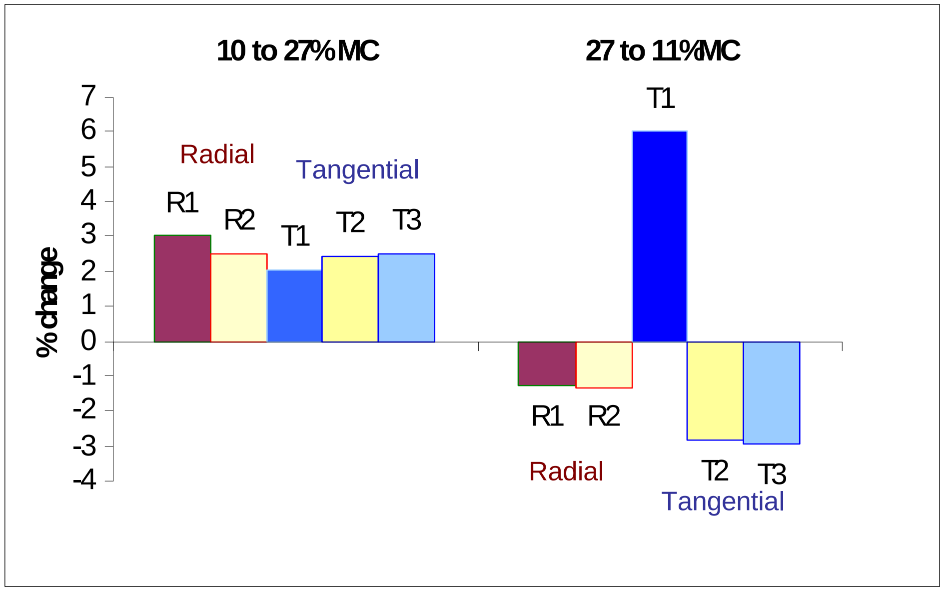
# Modelling shrinkage




Data from JP McLean (2007). University of Glasgow thesis

# Results

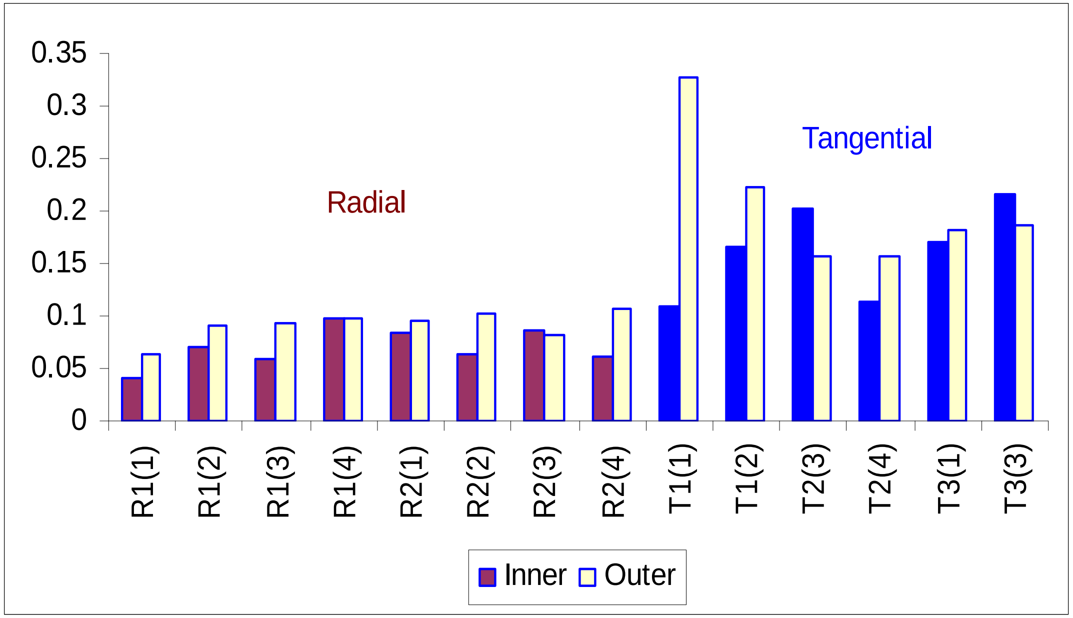





**On the left, the intact disc shows less variation between radial and tangential swelling than on the right where a crack has developed at T1.**
**Tangential shrinkage is roughly double that of radial after tension has been released.**

Strategic Integrated Research in Timber

# Results




**Approximate area of measurements; Inner** and **Outer**

**Variation in measurements taken near to the pith (inner) compared with those taken nearer the bark (outer) in a quartered disc. Mean radial shrinkage was greater in the outer than in the inner part of each segment ($p = 0.02$)**

# Conclusions

**As soon as a radial crack dissipated some of the tension, tangential shrinkage exceeded radial shrinkage by almost a factor of two.**

**Radial shrinkage was significantly less in the inner than in the outer part of the disc but this effect was small compared to the difference between radial and tangential shrinkage.**

**The results support the theory suggested by mechanism (2); that differences in MFA between radial and tangential planes or other unknown differences, appear to effect greater shrinkage in the tangential direction than in the radial direction.**

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