TECHNICAL SHEETS

FOR THE SUSTAINABLE MANAGEMENT OF TROPICAL FORESTS

FAIR & PRECIOUS BY atibt ÉDITIONS

3

SHRINKAGE OF TIMBER DURING DRYING

SHRINKAGE, DEFORMATION AND DRYING CRACKS

RETRAIT DU BOIS AU SHRINKAGE OF TIMBER DURING DRYING

Timber can contain several forms of water (see the Humidity in timber sheet). When its humidity rate content is below the fibre saturation point (FSP), humidity variations lead to dimensional changes. In a given direction of timber, total shrinkage is calculated as the ratio between the dimensional change between dry timber and timber at FSP on the dry timber dimension.

$$R=\frac{[Dim(PSF)-Dim(0\%)]}{Dim(0\%)}$$	Dimension with H ≥ FSP (PSF in diagram)	
		Dimension with H = 0%

The total shrinkage is variable depending on the timber and especially on the direction that is being considered. The total longitudinal shrinkage is the lowest (in the direction of the timber fibres), as low as 0.1%. The total radial shrinkage is more significant but remains limited by the presence of timber radii, and reaches 5% on average. Lastly, the total tangential shrinkage is the most significant because no cell is oriented in this direction, and reaches 10% on average.

$$\alpha=\frac{R}{PSF}$$

Shrinkage is proportional to the variation in humidity. The shrinkage coefficient α is defined by the dimensional change due to a 1% change in humidity content on the dimension of dry timber.

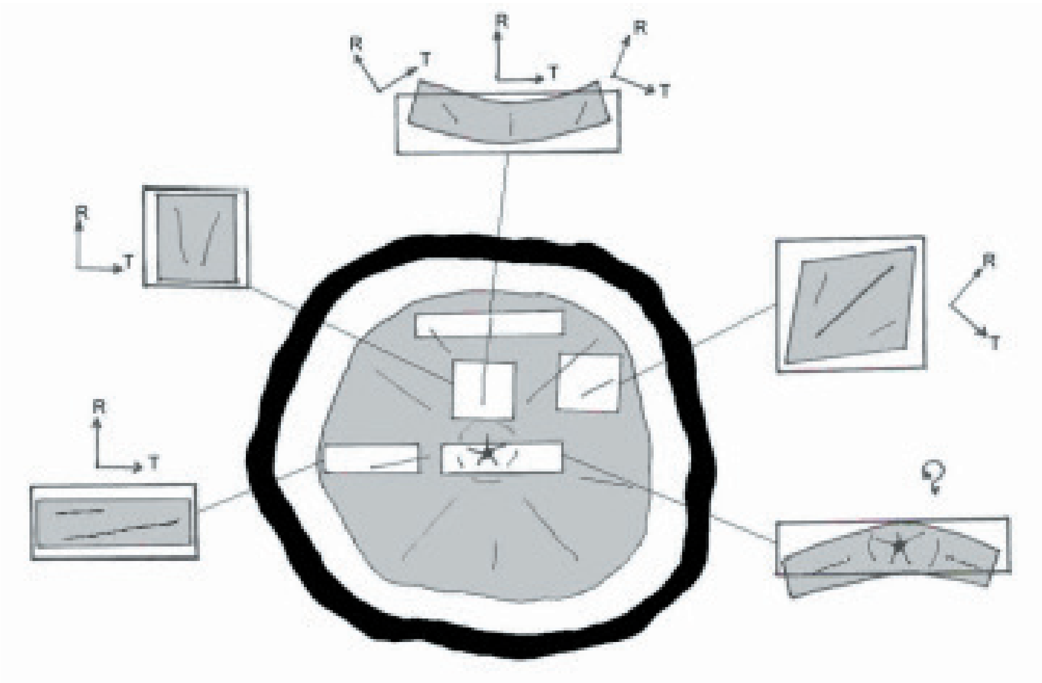
The dimensional variation is in fact easily calculated using the following formula:

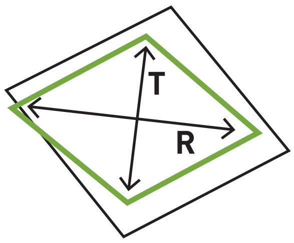
$\Delta l = \frac{\alpha \times \Delta H \times l}{100}$		Dimension ℓ1 With humidity H1
		Dimension ℓ2 With humidity H2
Assuming that H1 and H2 are less than the FSP		Δℓ = ℓ1 - ℓ2 ΔH = H1 - H2

On this link, a basic calculation tool in Excel can be used to estimate dimensional variations.
Note: the calculations show average values. The variability of timber is subject to surprises, even when there is no reaction timber present (see the corresponding sheet).

CROSS-SECTIONAL DEFORMATIONS DURING DRYING

As a result of the differences in shrinkage in the R and T directions, the timber deforms unevenly as it dries. As shrinkage in the R-direction is less pronounced (than in the T-direction), the timber is said to "pull towards the heart" when drying. The opposite is true for the absorption of humidity.





The justification of the deformation is easy to calculate:
In the example of a square Niangon block cut (12 cm diagonal cross-section), cut in a half-quarter.
If it changes from a 28% to 12% humidity content.

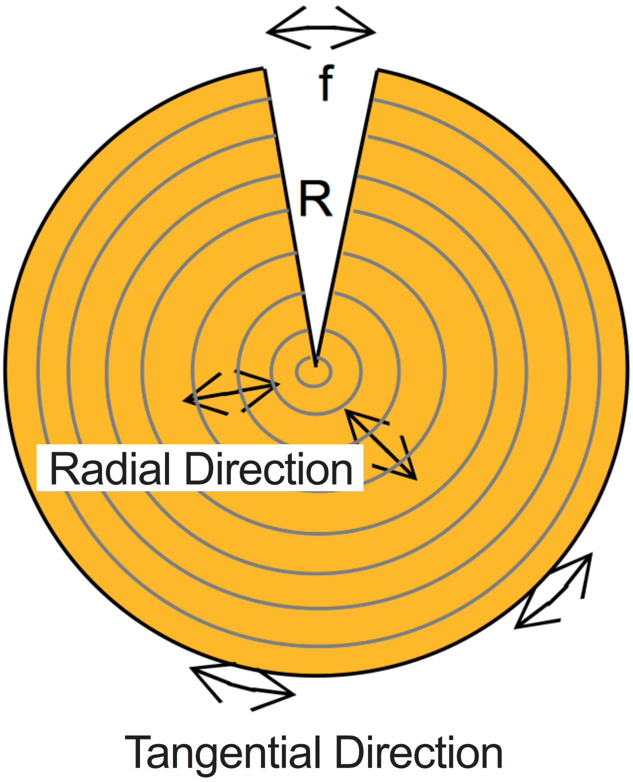
Radial shrinkage: **ΔR = 0,131 x (28-12) x 120/100 = 2,5 mm**
Tangential shrinkage: **ΔT = 0,275 x (28-12) x 120/100 = 5,3 mm**

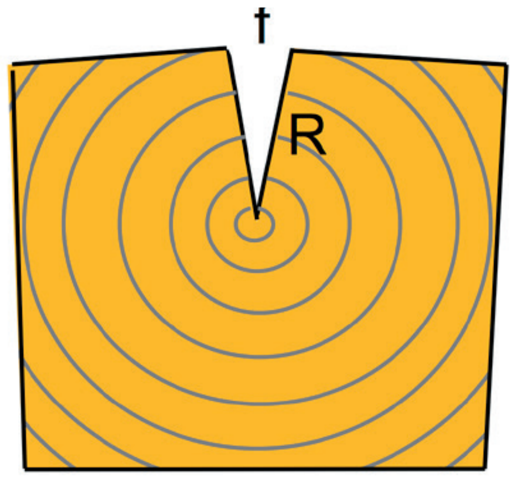
The diagonal in the T direction will be 2.8 mm smaller and will result in a diamond shape.

CLOSED HEART TIMBER CRACKS

In the case of a log where the heart of the timber is enclosed, and referred to as the "enclosed core", the differences in radial and tangential shrinkage mean that the periphery of a cut tends to shrink more than its radius.
As a result, the timber is subjected to perpendicular tensile stresses in the tangential direction, or cracks will occur. As the perpendicular tensile strength of timber is low, cracks occur in most cases.

The width of the crack can even be predicted by calculation, and depends on the radius, the timber's humidity variation (from the FSP), and the difference between the radial and tangential shrinkages.





$$f = \frac{\pi \times R \times (\alpha T - \alpha R) \times \Delta H}{50}$$

The locations of cracks in round timber is hard to predict. They occur at the shortest distance between the heart and the edge, or in the more fragile areas (near knots, for example).

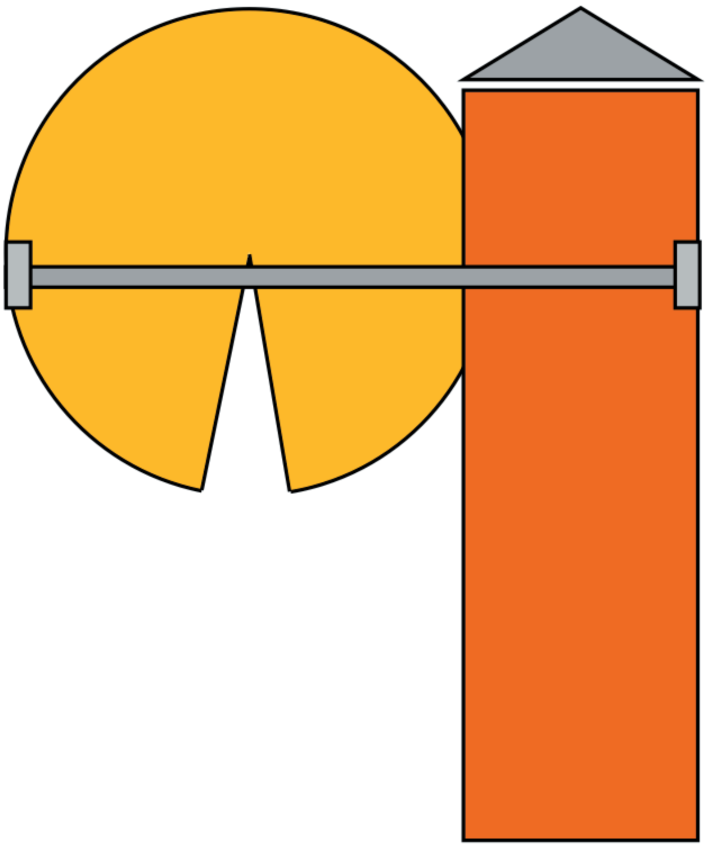
Example of an Azobe cant with a 300x300 mm cross-section, where the core is 100 mm from an edge, dried to a 15% humidity content.

f = π x 100 x (0,37 - 0,26) x (28 – 15) /50 = 9 mm

A crack should occur with a 9 mm opening on the side closest to the core.

These cracks generally have little effect on the mechanical strength of timber whose core is enclosed (except in bending when the crack is horizontal at the support points). The fibres of the timber are dissociated but not broken.
On the other hand, they can constitute water traps that can lead to fungal growth, as well as expose part of the timber that was not sufficiently durable or protected by a preservative treatment (surface protection or partial impregnation with a chemical product).

One technique used on road barriers is to deliberately create this crack by cutting a notch in the middle of the timber. This "notch" releases the deformation stresses and therefore limits the appearance of cracks in undesired areas (at assembly points, for example). The opening of the notch varies according to the humidity variations. It is generally done towards the bottom in order to not create a water trap.



Some large structural elements are reconstituted and are much more homogeneous. Their stability means that deformations are greatly reduced and that there are no (or few) problems with the appearance of cracks. These products are, among others: glued laminated timber, plywood...

Fair&Precious recommends the purchase of FSC® and PEFC-PAFC certified tropical timber.