Assessment of some wood characteristics of juvenile Teak from southern part of Mato Grosso, Brazil

Peter B. Laming 1) & Marina E. van der Zee 2)

1) Advisor Floresteca B.V., Zaandam, The Netherlands
2) SHR Timber Research, Wageningen, The Netherlands

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The heartwood of adult teak (*Tectona grandis* L.f.) is considered the most valuable tropical hardwood on the market, because of a combination of favourable wood characteristics: *decay resistance*, *strength*, *high dimensional stability*, and an *attractive colour* and *appearance*.

The teak plantation area in tropical countries in 2000 (FRA-FAO 2000) was *6 millions hectares* (*more than 90% in South East Asia*, with production based on rotations of 50-60 years).

Information and research on wood properties of natural grown teak and Asian plantation teak, are abundant.

Very scarce is the availability of technical data on teak managed with shorter rotation in Latin America and Caribbean, and in *Brazil* in particular, where commercial teak plantations cover over *50.000 hectares*, of which half of these in the southern part of Mato Grosso State, and based on rotations of *20-25 years* long.
Aim of the Study

• Provide some basic wood technological data on the heartwood and sapwood of juvenile teak, sustainably (FSC, ISO 14001) managed with short rotation (20-25 years) in Brazil. Is this young wood usable for high-quality exterior joinery under critical climatic application conditions?

• Analysis of some wood technological properties of Mato Grosso-grown teak, to assess data on its suitability of being transformed into industrially optimized, high-quality constructional elements, produced of the juvenile wood.
Growth area of the test material (1)

Southern part of Mato Grosso: source of the juvenile teak material
Question: is this juvenile wood a valuable raw material for the use of high-quality material to produce e.g. wooden façade-filling components?
Wood technological analysis performed on juvenile Brazilian Teak (1)

Basic knowledge needed for level determination of important technological characteristics for exterior use, under west-European conditions

- Fungal resistance (EN 350-1, EN 113)
- Dimensional stability [hysteresis, shrinkage] (DIN 52 184)
- Gluing properties (glue type, application technique)

Screening the test results of these fundamental properties to the technical requirements for the application (façade-filling elements)

When

Positive  Negative
Wood technological analysis performed on juvenile Brazilian Teak (2)

When

Positive

When

Negative

Pilot research on semi-industrial scale production

- semi-industrial methods for optimisation techniques
- semi-industrial adhesion techniques
- producing profiled elements for façade-filling components
- applying proper coating systems
- testing the semi-industrial produced articles on weathering behaviour and long-lasting exposure to the ruling climate conditions

Applicable for interior use only
Wood technological analysis performed on juvenile Brazilian Teak (3)

If the results of all the semi-industrial trials prove to be positive

Then approval for the production of façade-filling components and assigning Industrial Certification (KOMO, SGT)
Thinning Teak trees (2), in the yard
Area of origin of the test material (2)
Waxed end-grain cuts in the yard, with certification label
Arrival of the test material in Holland
Sampling

Schematic diagram of the sample orientation over the cross-section of the log.

Sampling method for the research into the natural durability and some physical properties of 7- and 8-year-old teak.
Results of the research into the fungal resistance and some physical characteristics of juvenile teak from the southern part of Mato Grosso, Brazil
The resistance to fungal attack in service -as well called the natural durability- was determined at laboratory-scale, according EN 350-1 and EN 113.

Fungi used: *Coniophora puteana* and *Gloeophyllum trabeum* (brown-rot fungi), and *Coriolus versicolor* (white-rot fungus).

Results are based on the elements of the $X$-Value
$\left[= \frac{\text{av. mass loss of the tested teak specimens}}{\text{av. mass loss of the reference specimens}} \right] (Fagus sylvatica L.; Beech)$
### Results of sapwood durability tests (2.2)

<table>
<thead>
<tr>
<th>Sapwood</th>
<th>Coniophora puteana</th>
<th>Gloeophyllum trabeum</th>
<th>Coriolus versicolor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mass loss</td>
<td>X-value</td>
<td>Mass loss</td>
</tr>
<tr>
<td>Reference beech</td>
<td>44,4%</td>
<td></td>
<td>38,4%</td>
</tr>
<tr>
<td>Median full sapwood sampl.</td>
<td>1,5%</td>
<td>0,03</td>
<td>0,8%</td>
</tr>
<tr>
<td>Durability class acc. EN 350-1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>
## Results of heartwood durability tests (2.3)

<table>
<thead>
<tr>
<th>Heartwood</th>
<th>Coniophora puteana</th>
<th>Coriolus versicolor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mass loss</td>
<td>X-value</td>
</tr>
<tr>
<td>Reference beech</td>
<td>43,8%</td>
<td></td>
</tr>
<tr>
<td>Median full heartwood samples</td>
<td>1,3%</td>
<td>0,03</td>
</tr>
<tr>
<td><strong>Durability class acc. EN 350-1</strong></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
Results of durability tests (2.4 a)

X-Value graph of the resistance of the sapwood and the heartwood of 7- and 8-year-old teak logs vs the white-rot fungus *Coriolus versicolor*. 
Results of durability tests (2.4 b)

Teak sapwood test pieces (left), on left and right side and teak heartwood test pieces (right), with a beech sample as the reference (in middle position), after 16 weeks exposure on *Coriolus versicolor*. 
Results of durability tests (2.5 a)

X-Value graph of the resistance of the sapwood and the heartwood of 7- and 8-year-old teak logs vs the brown-rot fungus Coniophora puteana.
Results of durability tests (2.5 b)

Teak sapwood test pieces (left), on left and right side and teak heartwood test pieces (right), with a beech sample as the reference (in middle position), after 16 weeks exposure on *Coriolus versicolor*. 
Results of durability tests (2.6)

X-Value graph of the experienced average resistance values of the sapwood vs three fungi.
In words:

Following EN 350-1, for the sapwood *durability class 1* is found for the brown-rot fungi, and *durability class 3* is found for the white-rot fungus. 
*So, the sapwood is classified as: durability class 3.*

The fungal resistance of the heartwood is found to be *durability class 1* for the brown-rot fungi, and *class 2* for the white-rot fungus. 
Durability of the heartwood is highest adjacent to the sapwood; this location could be rated in durability class 1. 
*So, the heartwood is classified as: durability class 2.*
The moisture content (MC) of the investigated 7- and 8-year-old teak heartwood and sapwood, was determined. The equilibrium moisture content (EMC) was related to both the relative humidity (RH) and the measure of shrinkage and swelling, radially and tangentially. Additionally, the measure of longitudinal shrinkage and density, is included.

EMC and shrinkage/swelling were determined at a number of relative climate conditions. The following series of relative humidities was used: green-state - 95% - 90% - 80% - 65% -55% - 35% - oven-dry
Graphs of the hysteresis and the shrinkage/swelling of the sapwood of juvenile Brazilian Teak (3.2)
Graphs of the hysteresis and the shrinkage/swelling of the heartwood of juvenile Brazilian Teak (3.3)

**Hysteresis**  
(Desorption & adsorption)

**Transversal shrinkage & swelling**
Overview of shrinkage values in sapwood and heartwood of juvenile Brazilian teak (3.4)

In figures

Average values for the shrinkage from green to some different relative humidities (RH).

<table>
<thead>
<tr>
<th>Average values for 7- and 8-year-old logs</th>
<th>Radial (%)</th>
<th>Tangential (%)</th>
<th>Longitudinal (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sapwood</td>
<td>Heartwood</td>
<td>Sapwood</td>
</tr>
<tr>
<td>fm green - 95% RH</td>
<td>0,44</td>
<td>0,48</td>
<td>1,02</td>
</tr>
<tr>
<td>fm green - 90% RH</td>
<td>0,50</td>
<td>0,53</td>
<td>1,08</td>
</tr>
<tr>
<td>fm green - 80% RH</td>
<td>0,64</td>
<td>0,71</td>
<td>1,37</td>
</tr>
<tr>
<td>fm green - 65% RH</td>
<td>1,51</td>
<td>1,43</td>
<td>2,72</td>
</tr>
<tr>
<td>fm green - 35% RH</td>
<td>1,87</td>
<td>1,79</td>
<td>3,7</td>
</tr>
<tr>
<td>fm green - oven-dry</td>
<td>2,39</td>
<td>2,34</td>
<td>4,7</td>
</tr>
</tbody>
</table>
In words

The variance in the shrinkage and swelling experiments proved to be relatively large as a result of the relative strongly curved growth rings being a normal phenomenon in small-diameter logs, especially in the heartwood.

Shrinkage and swelling in the sapwood showed slightly larger compared to the heartwood, which is quite normal.

Maximum tangential shrinkage showed below 5%, and radially below 2.4%.

At a moisture content relevant to practice, e.g. at 65% RH, only a slight difference in shrinkage values in sapwood and heartwood in this very young material, was found.

Radial shrinkage from green to 11-11.5% EMC in both heartwood and sapwood, is 1.1%; the tangential shrinkage averages 1.9% and 2.3%, respectively.

The longitudinal shrinkage from green to 65% was 0.23% for heartwood and 0.17% for sapwood.
The role of the movement of Brazilian Teak (1)

A high-quality component to be used in external joinery conditions, e.g. as façade-filling elements, requires a good and attractive dimensional stability, termed as movement in service.

After determination the hysteresis and shrinkage/swelling movement, the following results for the movement are presented:

<table>
<thead>
<tr>
<th></th>
<th>sapwood</th>
<th>heartwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC in 90% RH</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>MC in 60% RH</td>
<td>11.5%</td>
<td>12%</td>
</tr>
<tr>
<td>Corresponding radial movement</td>
<td>0.85%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Corresponding tangential movement</td>
<td>1.1%</td>
<td>1.25%</td>
</tr>
</tbody>
</table>

The level of the movement figures shown, is classified as small.
The role of the movement of Brazilian Teak (2)

The juvenile teak shows a good and attractive dimensional stability under changing climatic conditions. This essential property is a prerequisite to prevent defects and damages in the wooden constructions and coating disruptions in externally used components with connections and optimized products.

Photographs courtesy of SHR Timber Research
Density of juvenile Brazilian Teak

Graphs showing the density at 12 – 14% M.C., of 7-year-old and 8- year-old plantation teak; average of 4 logs.
Checking the commercial significance of continuing research into this juvenile teak, the level of the obtained results in the durability and physical properties research, was screened against the selection criteria set for the level of acceptability for producing high-class joinery articles, being guaranteed and certified products.
Screening of found property level against criteria for high-quality production (4.2)

When

Positive  Negative

Applicable for interior use only

The result of the screening procedure was such, that continuation of the research programme is fully justified: the intended semi-industrial trials for current high-quality products of optimized components, have been recently initiated.
Question: is this juvenile wood a valuable raw material for the use of high-quality material to produce e.g. wooden façade-filling components?

Answer: based on the high level of the basic properties in this juvenile material: YES
THE END

... THANK YOU ALL FOR YOUR ATTENTION