Fundamental properties of Masson Pine (Pinus massoniana Lamb.) Wood from Plantation

Shuqin ZHANG
Benhua FEI

Sustainable Development of Wood and Biomass in our New Global Economy
August 27-31, 2012
Beijing, China
Masson pine plantation in China

native to a wide area of central and southern China
fast-growing & important commercial species
the area of 3.36 million hm²
accumulation of 157.93 million m³
The objective of this study

To better and efficiently utilize the Masson pine wood from plantation, it is essential to study the basic wood properties important to manufacturing processes and uses, including density $\rho$, microfibril angle (MFA), modulus of elasticity (MOE), and so on.
# Materials

Huangshan plantation stand

1.5 mm (R) × 10 mm (T) × 80 mm (L)

<table>
<thead>
<tr>
<th>Tree No.</th>
<th>DBH (cm)</th>
<th>Tree height (m)</th>
<th>Clear length (m)</th>
<th>Growth ring (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23.8</td>
<td>14.0</td>
<td>7.3</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>31.9</td>
<td>19.0</td>
<td>11.0</td>
<td>44</td>
</tr>
<tr>
<td>3</td>
<td>25.1</td>
<td>14.0</td>
<td>5.3</td>
<td>33</td>
</tr>
<tr>
<td>5</td>
<td>28.9</td>
<td>19.0</td>
<td>13.8</td>
<td>43</td>
</tr>
<tr>
<td>7</td>
<td>22.0</td>
<td>17.0</td>
<td>11.8</td>
<td>41</td>
</tr>
<tr>
<td>8</td>
<td>23.3</td>
<td>16.3</td>
<td>11.3</td>
<td>43</td>
</tr>
<tr>
<td>9</td>
<td>39.8</td>
<td>19.7</td>
<td>9.7</td>
<td>43</td>
</tr>
<tr>
<td>10</td>
<td>31.8</td>
<td>18.3</td>
<td>10.0</td>
<td>42</td>
</tr>
<tr>
<td>11</td>
<td>30.0</td>
<td>20.0</td>
<td>11.5</td>
<td>44</td>
</tr>
<tr>
<td>12</td>
<td>40.3</td>
<td>22.0</td>
<td>11.3</td>
<td>44</td>
</tr>
<tr>
<td>13</td>
<td>44.3</td>
<td>20.0</td>
<td>12.0</td>
<td>43</td>
</tr>
<tr>
<td>14</td>
<td>43.7</td>
<td>20.0</td>
<td>10.0</td>
<td>43</td>
</tr>
<tr>
<td>15</td>
<td>33.5</td>
<td>18.0</td>
<td>8.0</td>
<td>37</td>
</tr>
<tr>
<td>16</td>
<td>27.0</td>
<td>16.3</td>
<td>10.8</td>
<td>41</td>
</tr>
<tr>
<td>17</td>
<td>28.0</td>
<td>15.6</td>
<td>9.6</td>
<td>34</td>
</tr>
<tr>
<td>18</td>
<td>20.6</td>
<td>16.3</td>
<td>12.3</td>
<td>38</td>
</tr>
<tr>
<td>19</td>
<td>32.1</td>
<td>18.5</td>
<td>9.5</td>
<td>37</td>
</tr>
<tr>
<td>20</td>
<td>34.7</td>
<td>20.0</td>
<td>12.6</td>
<td>44</td>
</tr>
<tr>
<td>21</td>
<td>31.6</td>
<td>18.3</td>
<td>10.3</td>
<td>41</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>31.2</strong></td>
<td><strong>18.0</strong></td>
<td><strong>10.4</strong></td>
<td><strong>40</strong></td>
</tr>
</tbody>
</table>
Measurement of MFA

PHILIPS X’Pert PRO PW3050/60
2θ=22.4°, 2 mm diverging slit, 1 mm receiving slit, 0.5 sec/step, scan step size 1°
Measurement of MFA

MFA = 0.6T

Graph showing intensity (counts) vs. scan angle (deg.) for different rings.

Equation:

\[ 2w = w_1 / \sqrt{\ln(4)} \]

- \( A, w > 0 \)
- offset: \( y_0 = 0 \)
- center: \( x_c = 0 \)
- width: \( w = 1 \)
- amplitude: \( A = 10 \)
Measurement of tensile $E_L$

INSTRON 5848 Micro-Tester
250 N grip air of
2 kN static load cell
25 mm dynamic extensometer
1.5 mm/min loading rate
max. load $= 350$ N
Measurement of density

Gravimetric method
Results of basic density

lowest near the pith, increasing outwards

- Mean = 0.428 g/cm³
- N = 713
- SD = 0.090 g/cm³
Results of MFA

decrease from pith to about 20th ring and then to remain stable in all trees

Mean=17.5°
N=1020
SD=7.3°
Results of tensile $E_L$

Average of 11.2 Gpa, corresponding COV of 48%

Longitudinal strain increases
from 0.08% to 0.4%
as MFA increases
from 10.3° to 41.1°
when the stress is 17 MPa.
Conclusion

It is the first time to experimentally determine the $E_L$ in China. The average wood basic density, MFA and tensile $E_L$ at 14% MC are 0.428 g/cm$^3$, 17.5° and 11.2 GPa. These data may serve as a basis for the efficient utilization. This study has important basic and practical meanings.
Thanks for your attentions!