Strength grading of Eucalyptus round timber:

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Outline

• Introduction
• Grading System
• Material & Methods
• Results / observations
  Characteristic values
  EN 338 Strength class
• Conclusions
Round wood for Structures

- small-diameter (100mm-160mm)
- e.g. from thinnings
- from clear felling: top ends
- diameter to small to be cut to rectangular sections

Roundwood Application

- Roof trusses
- Platform supports
- Observation tower
- Special joint connection
Typical applications of Eucalyptus Cloeziana poles

Hydraulic engineering applications

Mooring posts
Platform supports

Sheet Pile Walls

Introduction

Roundwood for Structures

• Timber is not available via the commercial routes
• Shape of the timber requires special attention of designers
• Lack of standards with regard to strength classes and test methods
• Strength values, are not yet available for engineers
**Round wood definition**

- Debarked only

- Typical for round poles
  - Tapered
  - Non circular section
  - Initial curvature
  - Pith enclosed -> Cracks
  - Rough surface

**Relevant Standards**

- **prEN 14544** Timber structures — Structural timber with round cross-section — Requirements
- **EN 14251** Structural Round Timber – Test Methods
- **EN 384** Structural timber - Determination of characteristic values of mechanical properties and density
- **EN 1310** Round and sawn timber - Methods of measurements of features
Scheme to establish strength classes

Diameter of the logs
- Graded according to...
- MOE
- MOR
- Density
- MC

Subgroup 1
Subgroup 2
Subgroup n

Establish the Population
Eucalyptus from R.S.A.

Determine strength properties
Determine characteristic strength values

Strength class: D.., D..

Material investigated

<table>
<thead>
<tr>
<th>Series</th>
<th>Diameter [mm]</th>
<th>Specimen (n)</th>
<th>Length test piece [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>(EA)</td>
<td>110-130</td>
<td>40</td>
<td>2200</td>
</tr>
<tr>
<td>(EB)</td>
<td>140-160</td>
<td>43</td>
<td>2700</td>
</tr>
<tr>
<td>(EC)</td>
<td>170-190</td>
<td>43</td>
<td>3300</td>
</tr>
</tbody>
</table>

2 production categories
- from clear cut felling (C) n = 48
- from thinning (T) n = 78
Material investigated

- Cracks
- Initial curvature
- Non-circular, varying section
- Irregular surface
- Taper
- High moisture content

Visual Characteristics

Grading of the sample according to:

<table>
<thead>
<tr>
<th></th>
<th>Individual knots</th>
<th>Knot group over 150 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max knot diameter</td>
<td>Sum knot diameters</td>
</tr>
<tr>
<td></td>
<td>x local pole circumference [mm]</td>
<td>x local pole circumference [mm]</td>
</tr>
<tr>
<td>SANS 754:2007</td>
<td>16%</td>
<td>33%</td>
</tr>
</tbody>
</table>

- Knot values found smaller than allowed (max approx 30 mm)
- Sample not representative for Grading acc. to standard used
Characteristics determined

- Bending strength
- Compression strength
- Modulus of elasticity in bending (global, static & dynamic)
- Density
- MC

Density and moisture content

- Drying and weighing
- Fault free part section
- Near to the failure location
- Volume changes by drying measured

\[ y = 0.1428x + 0.0926 \]

- Initial moisture content (IMC) [kg/kg]
- Volume shrinkage due to drying to 0%
Density and moisture content

Modulus of Elasticity/Bending Strength

Test arrangement acc. To EN14251
Compressive Strength

Test arrangement

Interpretation Results

- Calculation of MOR, MOE acc to EN14251
  - Average dimensions over central 6D section
  - I, W, based on dimensions central section

- Global MOE measured, adjustment to MOE_{local} based on EN384

- Adjustments for MC on both stiffness and strength values
  - Stiffness acc. EN384
  - Strength based on modification factors EC5 (use in service class 3)
Bending Strength vs MOE per diameter categories

Results

Bending Strength vs MOE per production category

Results
**Bending Strength**

EN384: $f_{m,0,k} = 78 \text{ MPa (from tests, } n=126)$

**Compression Strength**

EN384: $f_{c,0,k} = 36 \text{ MPa (from tests, } n=108)$
**Characteristic Strength Values**

**Adjusted according to EN 384**

### EN384 characteristic values

<table>
<thead>
<tr>
<th>Number of samples</th>
<th>1 Clear Cut + Thinnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallest sample size</td>
<td>135</td>
</tr>
<tr>
<td>MOR</td>
<td>89</td>
</tr>
<tr>
<td>MOE</td>
<td>597</td>
</tr>
<tr>
<td>k</td>
<td>0.8</td>
</tr>
<tr>
<td>R</td>
<td>175</td>
</tr>
<tr>
<td>F̄</td>
<td>485</td>
</tr>
</tbody>
</table>

**Additional compression tests**

- Smallest sample size: 108
- k | 0.8 |
- R₀ | 40 | N/mm² |
- F̄₀ | 36 | N/mm² |

**Discussion Results**

- **Round poles vs sawn timber**
  - **Influence factor**
    - Cutting of fibers: +
    - Juvenile wood: +
    - Knot influence: +
  - **Effect**
    - Pole: +
    - Sawn: -
Round poles vs sawn timber

comparison with sawn timber eucalyptus seems to confirm the differences

Modulus of Elasticity (dynamic)

Test arrangement $E_{dy}$

GrindoSonic MK5

$E_{dy} = 4 \cdot f^2 \cdot f^2 \cdot \rho \cdot [MPa]$
**Results**

- Regression coefficients differ
- Larger spread in results
- Further research to explain differences with known values
  - Influence taper / irregular section on dynamic measurement?

**Conclusion**

**Strength class for Eucalyptus round poles**

- Characteristic values of both strength and the modulus of elasticity of the samples are clearly higher than the strength and stiffness properties of strength class the sample is assigned to.
- The strength class of the tested lot Eucalyptus poles results in: **D50**. Measured Strength and stiffness would allow classification as **D70**.
- Strength classes for round poles could be beneficial.
  - Not after testing / gathering additional test results
Thank you for your attention.