Wood properties of *Sequoia sempervirens* grown in New Zealand and California
A Comparison
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**Abstract**

The properties of two sample groups of wood specimens, one from New Zealand and the other from California were compared. The properties of appearance, density, shrinkage, static bending strength – Modulus of Rupture (MoR) and static bending stiffness – Modulus of Elasticity (MoE) were measured. The results are limited by the small sample sizes of specimens. However, based on these results it is concluded that there was no significant difference in the wood properties of the coastal redwood grown in New Zealand and the coastal redwood grown in California and that the wood properties were similar to those previously reported for California-grown, young growth coastal redwood.

**Introduction**

Coastal redwoods (*Sequoia sempervirens*), native to California, were first planted in New Zealand in the mid-20th century. First reported in about 1860 [3,11] since that time various trials were planted in different regions of both the North Island and South Island of New Zealand with varying degrees of success. Of the more than 50,000 hectares (about 124,000 acres) of coast redwoods planted in New Zealand it was estimated that only about 350 hectares remained in 1966 [5]. Recent reports on New Zealand-grown coastal redwood are showing promise (about 12,400 acres) of coast redwoods planted in New Zealand it was estimated that 350 hectares remained in 1966 [5].

**Materials and Methods**

The experimental design compared wood properties between two samples of coast redwood, a New Zealand-grown sample and a California-grown sample. Specimen locations are listed in Table 2. Sample size was restricted by time and budget and the small sample size reduces the strength of the conclusions but provides reliable evidence differentiating wood from New Zealand and California. All material was collected from young-growth trees (estimated to be less than 50 years old).

**Density and Specific Gravity**

Density and specific gravity were measured from 50 mm long specimens following the standard test methods of ASTM D2730-04 [1] after the bending test. Specimens were equilibrated in a controlled 10 percent moisture content environment and were measured at the time of the bending tests.

**Shrinkage**

Each specimen was measured in length, thickness, and volume at three moisture content conditions: time of test, fully saturated, and oven-dry. Volumetric dimensional change (shrinkage) was calculated for each specimen.

**Bending Strength and Stiffness**

The standard [2] bending test was used to calculate the strength MoR and stiffness MoE of each sample. The 410 mm test specimen using Baldwin 60,000 pound capacity universal testing machine (Figure 1). Failure over a span of 200 mm stress and strain (deformation) were measured.

**Results**

**Appearance**

A subjective test using nine participants categorized all samples into three groups based on color, grain pattern, weight, and a combination of two or more characteristics.

**Density and Specific Gravity**

Analysis of the density data reveals a tendency for slightly lower values but less variation in the New Zealand sample than in the California sample.

**Shrinkage**

Volumetric shrinkage is greater for the New Zealand (7.0%) sample than for the California sample (5.4%), but the range of average is similar for both the New Zealand and the California sample. No statistical difference between the two samples was noted.

**Bending Strength and Stiffness**

The statistical analysis revealed that the MoE of 5755 MPa for the New Zealand sample is not significantly different from the MoE of 5740 MPa for the California sample. Similarly the New Zealand MoR of 27 MPa is not significantly different from the MoR of 26 MPa for the California sample.

**Conclusions**

Based on the results of this study it is concluded that there was no significant difference in the wood properties of a sample of coastal redwood grown in New Zealand and a sample of coastal redwood grown in California and that the wood properties are similar to those previously reported for California-grown, young growth coastal redwood. The summary of mean values of the New Zealand and California samples and how they compare to the commonly cited values (Wood Handbook) for California-grown, young growth is presented in Table 3. The sample sizes are insufficient to parse regional differences but the mean values are presented as they show trends of possible trends.

**Table 1:** Properties of wood collected from literature. *±*, standard deviation; †, percentage; ‡, percentage; ††, MPa

<table>
<thead>
<tr>
<th>Species</th>
<th>Moisture Content</th>
<th>Density (g/cm²)</th>
<th>MoE (MPa)</th>
<th>MoR (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>Time of test</td>
<td>1.13</td>
<td>7910</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Fully saturated</td>
<td>1.13</td>
<td>7955</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Oven-dry</td>
<td>1.13</td>
<td>7995</td>
<td>59</td>
</tr>
<tr>
<td>California</td>
<td>Time of test</td>
<td>1.35</td>
<td>7995</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Fully saturated</td>
<td>1.35</td>
<td>7995</td>
<td>63</td>
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<td>1.35</td>
<td>7995</td>
<td>63</td>
</tr>
</tbody>
</table>

**Table 2:** Source of samples tested. *Number of NZ trees or CA boards † Total Number of Specimens from Location

All samples were collected in 2013 and sent to the University of California forest products laboratory for specimen preparation and testing. The following were tested.

**Appearance**

A subjective test using nine participants categorized all samples into three groups based on color, grain pattern, weight, and a combination of two or more characteristics.

**Acknowledgements**

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