# Robusta Eucalyptus Wood: Its Properties and Uses

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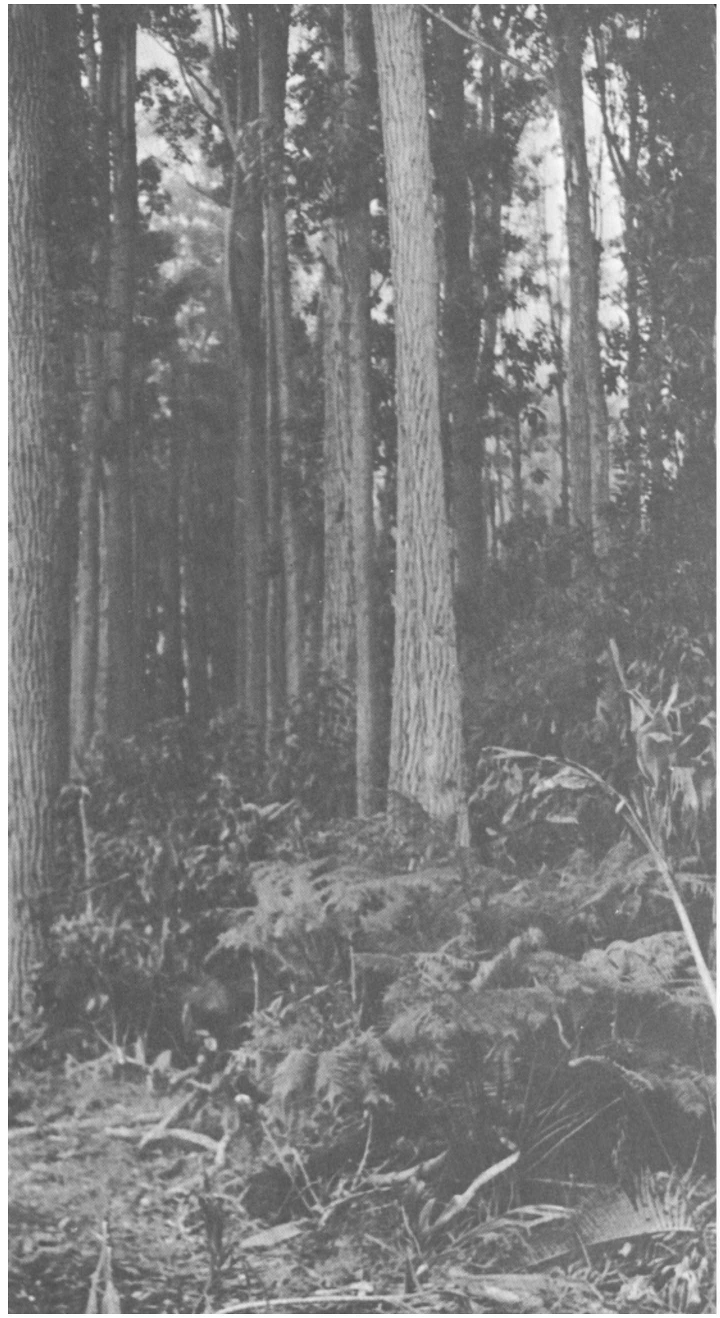
**Roger G. Skolmen's** first Forest Service assignment, in 1959, was as a member of the Experiment Station's soil-vegetation survey in Berkeley and Arcata, California. In early 1961, he joined the station's research staff in Honolulu, Hawaii, where he has been investigating the uses, properties, and processing of forest products. A native of San Francisco, he holds bachelor's and master's degrees in forestry from the University of California, Berkeley.

Robusta eucalyptus *(Eucalyptus robusta Sm.)*, known as swamp mahogany in its native Australia, is a tree now common in Hawaii. First introduced in the 1880's, it has since been widely planted on several islands. The robusta resource of the State today comprises some 110 million board feet of quality sawtimber averaging about 20 inches diameter at breast height and three 16-foot logs per tree. Most of this timber is in plantations of easy access; they range in size from less than 1 acre to several hundred acres. Approximate acreages of merchantable stands by island are:

| | *Acres* |
|---|---|
| Hawaii | 4,000 |
| Maui | 1,700 |
| Molokai | 300 |
| Oahu | 2,000 |
| Kauai | 1,600 |

Despite the abundance of the species, only recently has a start been made towards its full utilization. Marketing of robusta products has been hindered by lack of knowledge about the wood. Many adverse opinions are expressed, such as : "Eucalyptus? it's brittle--too heavy--too weak--too hard--splits in nailing--can't be dried!" But a good deal of information is available to show that these opinions are not well founded.

Much information has been gathered about robusta recently from local milling experience and through research, at the U.S. Forest Products Laboratory, at Madison, Wisconsin, supported by the Hawaii Forestry Division. This report brings this information together.



**A 40-year-old stand of robusta eucalyptus on Hutchinson Sugar Company land (Photo by Hawaiian Fern-Wood, Ltd.).**

# Physical Properties

## *Color and Figure*

The heartwood of robusta eucalyptus is light red to reddish brown in color as it comes from the saw. It darkens to a rich reddish brown in seasoning. The narrow 1- to 2-inch band of sapwood is gray to pale brown in dry lumber.

The wood is moderately coarse textured with an interlocked grain which usually produces a ribbon figure of light and dark stripes on quartersawn surfaces. Light and dark areas in growth rings and large vessel elements produce a subdued figure in seasoned wood. Occasional trees yield lumber with very attractive rippled or "fiddleback" figure.

**Robusta eucalyptus logs.**

### *Weight*

Robusta is a fairly heavy wood. At 46 pounds per cubic foot when air-dry, it is comparable to oak and hickory (Youngs 1960). White oak, for example, weighs 48 pounds per cubic foot air-dry. The weight, as with oak, must be considered in the use of robusta as a furniture wood. Its weight is not disadvantageous in flooring, paneling, and some construction.

### *Shrinkage*

The wood has high shrinkage in drying, slightly more than any comparable mainland hardwood (Youngs 1960). This high shrinkage, coupled with the interlocked grain, causes robusta to be a wood requiring careful drying in manufacture to avoid excessive loss. If put into service at close to the moisture content at which it will remain in service, robusta wood remains in place quite satisfactorily. This is especially true in the stable Hawaiian climate.

Proper use and manufacture can minimize problems caused by shrinkage and swelling. These problems are not unique to robusta. For example, water-saturated soil under two new Oahu homes recently caused flat-sawn white oak flooring to be raised from 9 percent moisture content to 12 percent. This 3 percent increase caused the flooring to swell, pushing out the walls of the houses $1^1/_2$ inches on two sides. It was calculated from shrinkage data that each $2^1/_4$-inch piece of strip flooring had swelled 0.023 inch.

Other flooring woods would have reacted similarly. Each piece of flat-sawn robusta flooring would have swelled 0.025 inch, 0.002 inch more than white oak. Sugar maple would have swelled the same as oak: 0.023 inch. Apitong, which has a higher shrinkage (and swelling) than robusta, would have swelled 0.026 inch. Quarter-sawn stock of all these species would have swelled much less.

A comparison of weight and total shrinkage for robusta and seven other woods used in Hawaii is given at the end of this report (table 3).

**⟵Milling robusta eucalyptus.**

# Mechanical Properties

## *Strength*

Robusta is a very strong wood. In strength properties other than shock resistance and hardness, it is stronger than most mainland woods of comparable density (tables 1 and 4). Index numbers (table 1) provide a convenient means of comparing properties of the various species. For example, let us compare robusta and white oak for flooring.

Properties of importance in flooring are shrinkage, hardness, and in Hawaii, where subfloors are seldom used, stiffness. Robusta, with a shrinkage index at 168, shrinks more than white oak at 153. Robusta is about as hard as white oak (112 vs. 108) and much stiffer (203 vs. 153). Therefore, in Hawaii, where a stable climate minimizes shrinking and swelling of wood in place, robusta should give service about equal to white oak. It is possible to compare only shrinkage and strength in this way, not appearance or durability.

Because it is such a strong wood, robusta can be used for construction in smaller sizes or over longer spans than most of the commonly used woods. The result is a saving in wood and, at equivalent prices, a saving in cost. Recently developed nailing devices could minimize possible higher labor costs in handling and nailing this hard, heavy wood.

## *Basic and Working Stresses*

The Forest Products Laboratory has suggested interim basic stress values for robusta in the absence of action by the American Society for Testing and Materials on Hawaii-grown species (Forest Products Laboratory 1960a). These values and the working stresses calculated from them are given at the end of this report together with a comparison of the similarly calculated stresses for Douglas-fir and redwood (table 5).

## *Stress Value for Poles*

The Forest Products Laboratory has recommended that robusta poles be assigned a fiber-stress value of 8,400 pounds per square inch and

*Table 1. Comparative shrinkage and strength ranking of some well-known woods and robusta eucalyptus*[1]

| Rank | Volumetric shrinkage | Bending strength | Compressive strength | Stiffness | Hardness | Shock resistance |
|---|---|---|---|---|---|---|
| 1. | Redwood (69) | ROBUSTA (120) | ROBUSTA (118) | Apitong (220) | Sugar maple (115) | Sugar maple (137) |
| 2. | Red lauan (121) | Apitong (114) | Apitong (108) | ROBUSTA (203) | ROBUSTA (112) | White oak (127) |
| 3. | Douglas-fir (122) | Sugar maple (114) | Sugar maple (104) | Douglas-fir (185) | White oak (108) | ROBUSTA (103) |
| 4. | Sugar maple (147) | White oak (102) | Douglas-fir (104) | Sugar maple (178) | Apitong (88) | Apitong (99) |
| 5. | White oak (153) | Douglas-fir (90) | Redwood (102) | Red lauan (162) | Red lauan (59) | Douglas-fir (86) |
| 6. | ROBUSTA (168) | Red lauan (90) | White oak (97) | White oak (153) | Douglas-fir (58) | Red lauan (82) |
| 7. | Apitong (186) | Redwood (82) | Red lauan (86) | Redwood (136) | Redwood (54) | Redwood (66) |

*[1]Strengthlisting based on comparative index numbers, shown in parentheses, calculated at the U.S. Forest Products Lab. by procedure outlined in U.S.D.A. Tech. Bul. 158—Comparative strength properties of woods grown in the United States (Youngs 1960). Philippine data calculated from Bellosillo and Miciano (1959).*

be used in sizes given for western larch poles in table 6 of "American Standard Specifications and Dimensions for Wood Poles," ASA Designation 05.1--1963. Though robusta is stronger than larch, use of the figures for larch, the strongest pole species listed, is recommended for ready correlation with existing standards (Forest Products Laboratory 1960b).

Round robusta posts have been pressure treated to more than acceptable standards with both oil- and water-borne preservatives. This work, done by a private wood treating company in Honolulu, indicates that poles can also be satisfactorily treated with preservatives.

# Durability

Heartwood of robusta eucalyptus has been tested for natural resistance to decay by the soil-block method (Clark 1961). These tests indicate that robusta is very resistant to a brown rot fungus. Compared with white oak, robusta is much more resistant to brown rot and slightly more resistant to white rot. Of four Hawaii-grown woods tested, including ohia, robusta was the most resistant to decay.

Long-term exposure tests of robusta and 14 other woods have been started in Makiki Valley, Honolulu, but final results of this research are not yet available. Nevertheless, there is some evidence that robusta is durable in Hawaii. Much of the lumber now being produced is from logs that have lain on the ground in wet forests 10 to 20 years without deterioration of heartwood. Robusta heartwood in use also shows resistance to termite and other insect attack. As in other species, only the heartwood is durable, not the sapwood.

# Other Characteristics

Though of concern chiefly to the primary manufacturer, certain characteristics in robusta that are not found in commonly known woods should be explained to the consumer.

### *Growth Stress*

In common with some other eucalypts and other species (such as *Shorea* spp. and *Khaya* spp.), particularly when plantation grown, robusta wood in the tree contains internal stresses along the grain that have built up during the life of the tree. As a result of these growth stresses, wood in the outer part of the tree is in tension, and that in the inner part is in compression.

Growth stress usually shows up immediately in bucking logs to length or in sawing cants from them. During bucking, logs usually split open on the end in one or two directions. Sometimes this end splitting occurs a few hours after bucking. End splits may continue to open in stored logs and result in even greater loss of wood. As much as 10 percent of the wood in a short log may be lost in trimming lumber that contains these splits.

Growth stress is also responsible for end checks in lumber reaching the market. End checks will not open further in properly dried lumber and for certain uses are not important. They may, however, seriously limit the salability of robusta lumber and should be trimmed off at the milt after drying. Hence lumber to be sold in standard lengths must be produced originally in considerably longer lengths.

Growth stress commonly causes slight crook or bow in long, large dimension pieces. The size of dimension stock, therefore, may affect certain uses, as in a recent case in which a piece of boat-building dimension stock was replaced by an over-size piece so that the slight bow could be adzed out to make a boat stem.

### *Brittleheart*

Another peculiarity, common to robusta and many other tropical hardwoods, is brittleheart. Probably as a result of growth stresses which cause long term compression loading of the first-formed juvenile wood near the pith, a central core of wood, especially in butt logs, is full of microscopic compression failures (Burgess 1957). This wood is extremely weak in shock resistance. Brittleheart usually has a characteristic color, torn fibers on end grain surfaces, or large compression failures on lumber faces that aid in its identification.

Wood suspected of being brittleheart *must* be excluded when the lumber is to be used for purposes requiring strength in shock resistance. This is accomplished at present by boxing the heart in sawing and segregating all lumber from the central part of the log. Lumber from the central portion is currently used entirely for stakes, each of which is strength tested during manufacture.

Unwittingly, a few pieces of brittleheart have on occasion been included in lumber shipments. These few pieces have resulted in the impression frequently heard that robusta is a brash wood. It is not, when the brittleheart portion is excluded.

### Pin Knots

A third peculiarity of robusta and some other hardwoods grown in Hawaii is. the frequent occurrence of minute, knot-like growth irregularities, usually 1/16 inch or less in diameter, in otherwise clear wood (Malcolm 1961). These irregularities are caused by "dormant bud strand" tissue extending radially from the log center. They appear as small eye-shaped blotches on flat-sawn lumber, or large medullary rays on quartered lumber (Jacobs 1955). Occasionally these structures contain pith and hence can be classed as true knots.

If robusta is used in a dry climate, or if it is kiln dried to a low moisture content, these irregularities usually will check minutely in the direction of the grain, but the checks can be filled satisfactorily in the finishing operation.

The smaller of these irregularities will require an exception under the standard grading rules of the National Hardwood Lumber Association if a reasonable grade recovery is to be achieved from robusta. As consumers become better acquainted with robusta lumber, these small irregularities may be found acceptable in many uses.

Tiny growth irregularities quite similar to those in robusta are frequently seen in the "Philippine mahoganies."

### Drying

Drying defects are most frequently mentioned as causes of rejection of robusta lumber. But properly dried robusta is not excessively warped or checked. In fact, very few pieces of dry lumber show much misalignment. Except for end splits due to other causes, robusta does not exhibit excessive splitting or checking in drying.

## Present Uses

The annual production of robusta lumber in Hawaii is about 500,000 board feet. Lumber produced is mostly of three thicknesses--1, 2, and 3 inches--and of lengths from 8 to 16 feet. This small output is converted to several products (table 2). More uses are continually being developed.

Heavy duty pallets made of robusta and fastened with tensioned spirally grooved nails have a long service life. In lighter pallets, robusta is excellent for the edge boards that take a terrific battering from forklift tines. It is now being tried for heavy sling cargo pallets by a shipping company.

Stakes, used to support irrigation ditch walls and gates, offer an excellent means of increasing over-all utilization of logs. The durability and strength of robusta make it highly regarded for stakes. Robusta stakes last a long time in the ground and can be driven repeatedly without splitting.

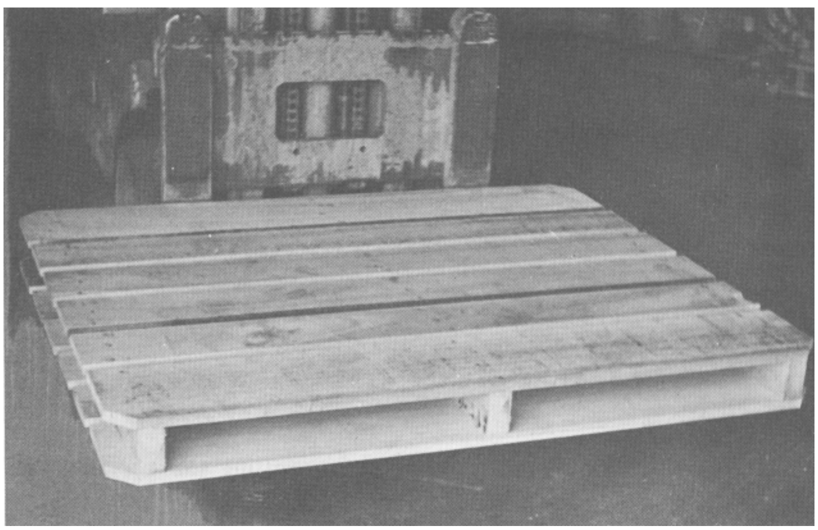
One sugar mill has used robusta for several years for flume construction and reports that it outwears steel plate in resisting the abrasion of rolling stones and mud. This abrasion resistance causes robusta to be valued for truck beds. Its strength results in its use as conveyor slats. Ranchers like robusta for corral fences and gates because it is strong and durable.

Besides excellent strength and wearing characteristics, robusta is a beautiful wood that takes a high polish and so makes an attractive floor. One home was built some years ago in Hilo with robusta siding that has remained in place very well and is holding its original paint satisfactorily.

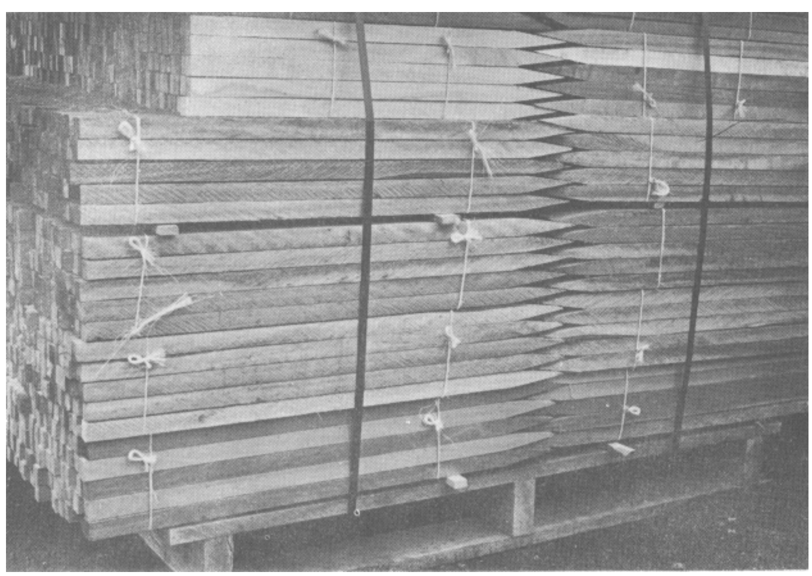
Robusta finds extensive use as both split and round posts on ranches and farms in Hawaii. A 5-inch post is estimated by ranchers to last 5 to 7 years untreated in wet areas having 100 or more inches of rain per year (Philipp 1961). In Makiki Valley, Honolulu, 3- to 5-inch posts have lasted slightly more than 2 years (Skolmen 1963). Treated with preservatives, such a post should last much longer.

*Table 2. Current uses of E. robusta in Hawaii*

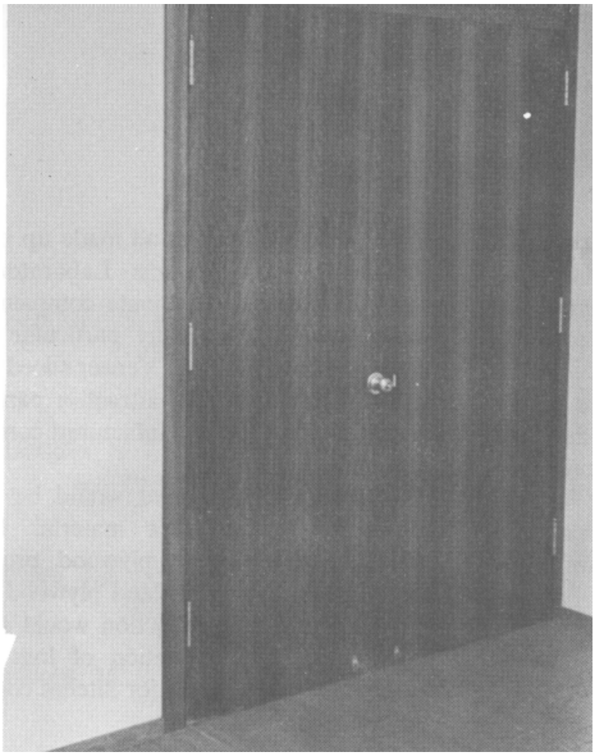
| Product | Consumers | Estimated annual production |
|---|---|---|
| | | *M board feet* |
| Pallets | Agriculture, shipping | 180 |
| Stakes | Sugar plantations | 150 |
| Flooring | Home construction | 40 |
| Conveyor slats | Sugar mills | 30 |
| Fences and gates | Ranches | 30 |
| Truck beds | Trucking companies | 20 |
| Residue flumes | Sugar mills | 10 |
| Siding and paneling | Home construction | 10 |
| Misc. construction | (Framing, boats, etc.) | 30 |



**A robusta pallet, rugged and long-lived.**

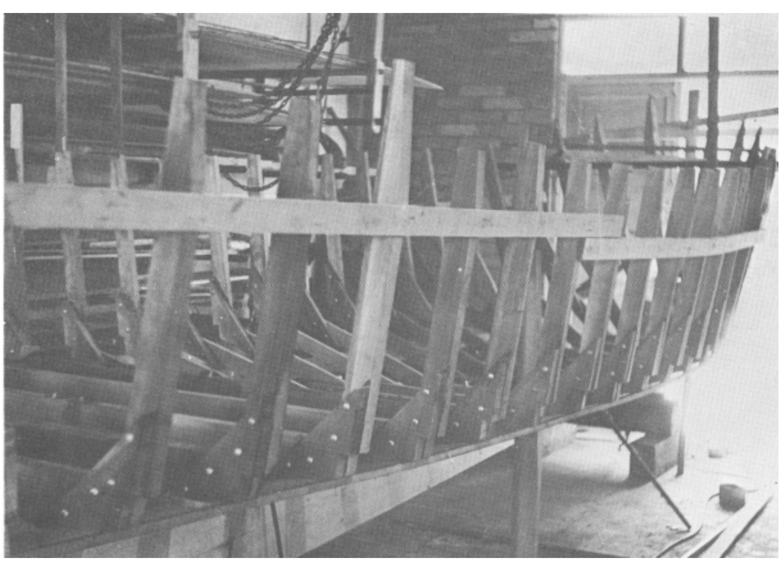


**Irrigation stakes bundled and strapped ready for shipment.**



**Doors faced with robusta veneer at the Hawaii Department of Agriculture Building, Honolulu.**

**Robusta floor in the Board Room, Hawaii Department of Agriculture.**



**Robusta frames in the new Kawaihae pilot boat--one of the most critical constructional uses to which a wood can be put.**

# Potential Uses

Single-wall house siding is an excellent potential market for robusta. The strength and durability of the wood should suit it to this use. Thinner siding could be used if the walls were desired to be equal in strength to redwood, the most commonly used siding. If used in the same thicknesses as redwood, robusta walls would be much stiffer. But because robusta shrinks and swells more than commonly used siding woods, it may not be suitable for use in those parts of Hawaii that have large seasonal changes in atmospheric moisture.

Robusta should also produce beautiful small-membered furniture of contemporary design. It is too heavy for bulky furniture, but its high strength suits it to light construction.

The strength and durability of robusta suit it well for highway guard rails. Considerable softwood is currently imported for this use.

Sliced veneer of robusta has been produced on an experimental basis and made up into plywood by the Forest Products Laboratory (Youngs 1960) and by three private companies. None of these producers had any particular difficulty in working with the wood. Veneer sliced on the quarter works up into very attractive panels. Robusta veneer is not being manufactured commercially at present.

A veneer slicing plant would be an excellent outlet for higher grade material. Face veneer could be exported to plywood producers elsewhere or used by an Island plywood plant if one is set up. Veneer production would not necessarily preclude Lull utilization of logs since lower grade material unsuited for flitches could be sawed into lumber.

To sum up, *Eucalyptus robusta* wood is excellent for purposes requiring high strength and for finish work where an attractively figured, dark reddish-brown wood is desired.

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*Address requests for copies to the originating office.

# Appendix

## Tables of Use to Architects, Engineers, Builders, and Lumber Manufacturers

*Table 3. Physical properties of robusta eucalyptus, ohia, and six woods commonly imported to Hawaii [1]*

| Species | Moisture content | Specific[2] gravity | Weight[3] per cubic foot | Total (green | | |
|---|---|---|---|---|---|---|
| | | | | Radial | Tangential | Volumetric |
| | *Percent* | | *Pounds* | - - - - | *Percent* - | - - - - |
| Robusta eucalyptus | 88 | 0.60 | 70 | 6.1 | 10.7 | -- |
| *(Eucalyptus robusta)* | 12 | .66 | 46 | -- | -- | -- |
| Ohia | 67 | .70 | 73 | 6.9 | 12.1 | 19.1 |
| *(Metrosideros collina)* | 12 | .81 | 57 | -- | -- | -- |
| Apitong[4] | 80 | .58 | 65 | 6.0 | 11.7 | 19.1 |
| *(Diptercarpus spp.)* | 12 | .70 | 49 | -- | -- | -- |
| Maple, sugar | 58 | .56 | 56 | 4.9 | 9.5 | 14.9 |
| *(Acer saccharum)* | 12 | .63 | 44 | -- | -- | -- |
| Oak, white | 68 | .60 | 62 | 5.3 | 9.0 | 15.8 |
| *(Quercus alba)* | 12 | .68 | 48 | -- | -- | -- |
| Douglas-fir (coast type) | 38 | .45 | 39 | 5.0 | 7.8 | 11.8 |
| *(Pseudotsuga menziesii)* | 12 | .48 | 34 | -- | -- | -- |
| Lauan, red[4] | 65 | .45 | 46 | 3.7 | 7.4 | 12.5 |
| *(Shorea negrosensis)* | 12 | .49 | 34 | -- | -- | -- |
| Redwood (virgin) | 112 | .38 | 50 | 2.6 | 4.4 | 6.8 |
| *(Sequoia sempervirens)* | 12 | .40 | 28 | -- | -- | -- |

[1] *Source: Youngs (1960).*
[2] *Based on weight when ovendry and volume at test.*
[3] *Based on combined weight of wood and moisture and volume at test.*
[4] *Source: Bellosillo and Miciano (1959).*

*Table 4. Mechanical properties of robusta eucalyptus, ohia, and six woods commonly imported to Hawaii*[1]

| Species | Moisture content | Static bending: Fiber stress at proportional limit | Static bending: Modulus of-- Rupture | Static bending: Modulus of-- Elasticity | Static bending: Work to-- Proportional limit | Static bending: Work to-- Max load | Compression parallel to grain: Fiber stress at P.L. | Compression parallel to grain: Maximum crushing strength | Hardness[2]: End | Hardness[2]: Side | Toughness[3]: Radial | Toughness[3]: Tangential |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Percent* | *Psi* | *Psi* | *1,000 Psi* | *In. lb. per cu. in.* | *In. lb. per cu. in.* | *Psi* | *Psi* | *Lb.* | *Lb.* | *In. lb.* | *In. lb.* |
| Robusta eucalyptus | 88 | 6,500 | 10,400 | 1,780 | 1.38 | 9.2 | 3,560 | 5,260 | 1,100 | 970 | 260 | 260 |
| | 12 | 8,200 | 15,600 | 2,200 | 1.77 | 14.5 | 4,150 | 8,200 | 1,670 | 1,330 | 270 | 280 |
| Ohia | 67 | 6,000 | 10,100 | 1,800 | 1.18 | 10.6 | 3,090 | 4,720 | 1,340 | 1,270 | 410 | 410 |
| | 12 | 10,700 | 18,300 | 2,370 | 2.75 | 16.7 | 5,270 | 8,900 | 2,390 | 2,090 | 380 | 390 |
| Apitong[4] | 80 | 5,200 | 8,890 | 1,710 | .88 | 7.5 | 2,680 | 4,320 | 790 | 800 | ------ 250 ------ | |
| | 12 | 10,100 | 16,700 | 2,500 | 2.40 | 15.3 | 4,790 | 8,840 | 1,600 | 1,410 | ------ 290 ------ | |
| Sugar maple | 58 | 5,100 | 9,400 | 1,550 | 1.03 | 13.3 | 2,850 | 4,020 | 1,070 | 970 | --------------- | |
| | 12 | 9,500 | 15,800 | 1,830 | 2.76 | 16.5 | 5.,390 | 7,830 | 1,840 | 1,450 | (190) | (190) |
| White oak | 68 | 4,700 | 8,300 | 1,250 | 1.08 | 11.6 | 3,090 | 3,560 | 1,120 | 1,060 | ---------------- | |
| | 12 | 8,200 | 15,200 | 1,780 | 2.27 | 14.8 | 4,760 | 7,440 | 1,520 | 1,360 | ---------------- | |
| Douglas-fir | 38 | 4,500 | 7,600 | 1,570 | .75 | 7.6 | 3,130 | 3,860 | 570 | 500 | 150 | 200 |
| | 12 | 7,800 | 12,200 | 1,950 | 1.77 | 9.8 | 5,850 | 7,430 | 900 | 710 | 140 | 200 |
| Red lauan[5] | 65 | 4,700 | 7,700 | 1,380 | .81 | 6.4 | 2,490 | 3,800 | 590 | 610 | ------- 310 ------ | |
| | 12 | 7,100 | 11,500 | 1,700 | 1.70 | 10.7 | 3,410 | 6,020 | 780 | 740 | ------- 240 ------ | |
| Redwood | 112 | 4,800 | 7,500 | 1,180 | 1.18 | 7.4 | 3,700 | 4,200 | 570 | 410 | (60) | (110) |
| | 12 | 6,900 | 10,000 | 1,340 | 2.04 | 6.9 | 4,560 | 6,150 | 790 | 480 | (50) | (80) |

[1] Source: Youngs (1960).
[2] Load required to imbed a 0.444-inch ball to half its diameter.
[3] Specimen size 0.79- b 0.79-inch tested over 9.47-inch span, except values indicated by ( ),which are based on 5/8- by 5/8-inch specimen tested over 8-inch span.
[4] Averages of 19 green and 9 air-dry average tree values of 6 (5 air-dry) Dipterocarpus spp. listed by Bellosillo and Miciano (1959).
[5] Averages of 7 green and 5 air-dry average tree values listed by Bellosillo and Miciano (1959).

*Table 5. Basic and working stresses for robusta eucalyptus, Douglas-fir, and redwood*[1]

| Item | Robusta | Douglas-fir (coast type) | Redwood |
|---|---|---|---|
| | *Psi* | *Psi* | *Psi* |
| Basic stress: | | | |
| Beams (bending) | | | |
| Long-time loading | 2,900 | 2,200 | 1,750 |
| Normal loading | 3,200 | 2,400 | 1,950 |
| Columns (compression parallel) | | | |
| Long-time loading | 1,900 | 1,450 | 1,350 |
| Normal loading | 2,100 | 1,600 | 1,500 |
| Working stress: | | | |
| Beams (bending) normal loading | | | |
| High grade[2] | 2,400 | 1,800 | 1,500 |
| Medium grade[3] | 1,600 | 1,200 | 1,000 |
| Columns (compression parallel) normal loading | | | |
| High and medium grades[4] | 1,500 | 1,200 | 1,100 |

[1] *Sources: Forest Products Laboratory (1960a); U.S. Department of Agriculture (1955).*

[2] *Assumed value 75% of basic stress as adjusted for 'normal' loading. Redwood and Douglas-fir adjusted similarly for comparison purposes. For actual working stresses of mainland woods consult National Lumber Manufacturers Association—National Design Specifications for Stress-Grade Lumber and Fastenings.*

[3] *Assumed value 50% of basic stress—also see footnote 2 above.*

[4] *Assumed value 75% of basic stress--see also footnote 2 above.*

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