United States
Department of
Agriculture

Forest Service

Forest
Products
Laboratory

Research
Note
FPL-RN-0260

Resistance Moisture Meter Correction Factors for Four Tropical Wood Species

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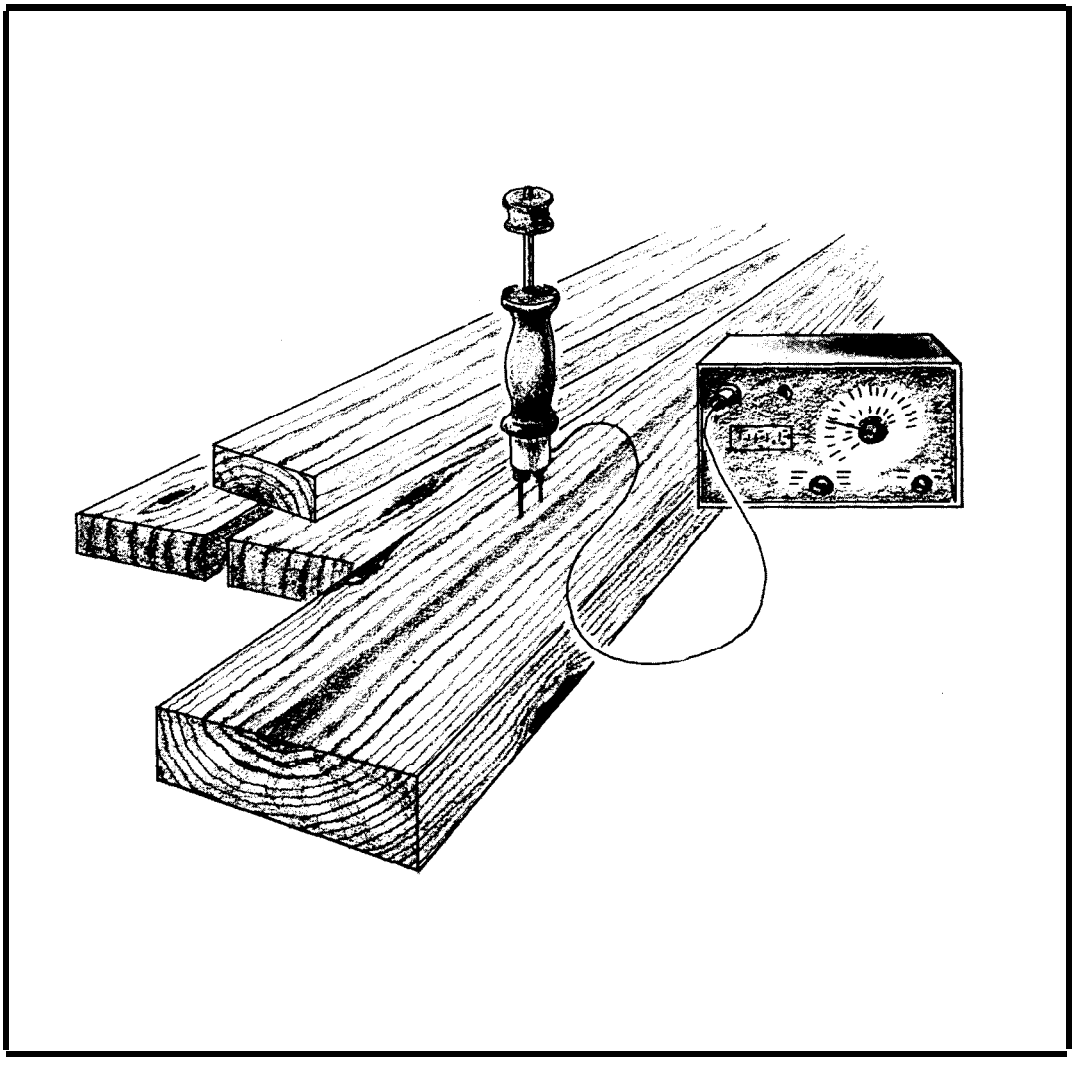

Abstract

Correction factors were determined for an electrical resistance-type moisture meter for African celtis (*Celtis* sp.), dahoma (*Piptadeniastrum africanum*), ramon (*Brosimum alicastrum*), and danto (*Vatairea lundellii*). For all species, correction factors were negative for most of the moisture content range, meaning that the meter readings were generally greater than the true moisture content. The 95-percent confidence intervals for true moisture content as a function of meter reading are given. The time drift of the true moisture content estimated from the corrected meter readings is also given.

Keywords: Tropical species, moisture meter, African celtis (*Celtis* sp.), dahoma (*Piptadeniastrum africanum*), ramon (*Brosimum alicastrum*), danto (*Vatairea lundellii*).

March 1994

Simpson, William T. 1994. Resistance moisture meter correction factors for four tropical wood species. Res. Note FPL-RN-0260. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 6 p.

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Resistance Moisture Meter Correction Factors for Four Tropical Wood Species

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Introduction

Electrical moisture meters correlate electrical resistance of wood with moisture content. The correlation depends on species, and most commercial moisture meters include a species correction table. For one type of meter, Pfaff and Garrahan (1984) published a handbook of correction factors for North American species. Except for jelutong (*Dyera costulata*) (Milota 1991), African mahogany (*Khaya* sp.), Honduran mahogany (*Swietenia* sp.), and Philippine mahogany (*Shorea* sp.) (Delmhorst 1990), correction factors for tropical species are not well known. The purpose of this study was to determine correction factors for an electrical resistance-type moisture meter for the tropical species African celtis (*Celtis* sp.), dahoma (*Piptadeniastrum africanum*), ramon (*Brosimum alicastrum*), and danto (*Vatairea lundellii*).

African celtis (*Celtis* sp.) has a basic specific gravity ranging from 0.52 to 0.65. Other common names are esa, ba, akasina, ita, ohia, mrinde, and diania (Chudnoff 1984). Celtis is used in flooring, tool handles, furniture, and general construction. Dahoma (*Piptadeniastrum africanum*) is also native to Africa. Other common names are mbeli, dabema, agboin, ekhimi, atui, bokungu, and mpewere. Basic specific gravity is 0.56, and uses are general construction, wharf decking, window and door frames, woodwork, railroad ties, and flooring. Ramon (*Brosimum alicastrum*) is native to Central and South America! Other common names are capomo, ojoche, masicaron, ojuste, guaimaro, manata, tillo, muiratinga, and janita. Basic specific gravity is 0.55 to 0.72; uses are general construction work, flooring, furniture, and tool handles. Danto (*Vatairea lundellii*) is native to Central and South America, and has a basic specific gravity that ranges from 0.55 to 0.64. Other common names are bitter angelim, faveira, amargoso, amargo, arisauru, yaksaru, mora, gele kabbes, and angelim; uses are construction work, flooring, general carpentry, and railroad ties. Additional information on these species is given by Chudnoff (1984).

Experimental

The two African species were shipped as logs from Ghana. Upon arrival at the Forest Products Laboratory, logs were sawn into lumber. The shipment contained only two logs of each species, so species representation was somewhat limited. Furthermore, only four boards of each species were available for determining the correction factors because the remaining boards were used in another study. The boards that were available were cross cut into sections 3 in. (76 mm) along the grain. Each consecutive section was assigned to one of five relative humidity (RH) conditions: 30,50,65,80, and 90 percent. Assignment was repeated until 15 sections were available for each relative humidity condition, making a total of 75 specimens per species.

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[1]The common name ramon is usually associated with *Trophis* spp. (Chudnoff 1984). which is also native to Central and South America, not *Brosimum alicastrum.* The Guatemalan supplier of the *Brosimum alicastrum* referred to it as ramon, so we use that common name in this report. Also, danto is not listed in Chudnoff (1984) as a common name for *Varairea lundellii,* but was called danto by the supplier.

The two American species were shipped as nominal 2- by 4-in. (51- by 102-mm) green lumber from Guatemala. When the lumber was still green, five 3-m- (76-mm-) long specimens were cut from each of 18 boards and assigned to the same five RH conditions as the African species, making a total of 90 specimens per species.

Specimens were conditioned in temperature and relative humidity controlled rooms at 80°F (27°C) until specimens showed both positive and negative weight changes. This observation indicated that specimens had reached equilibrium within the control limitations of the conditioning rooms. Total time in the rooms varied with the relative humidity. The shortest time was in the 30-percent RH room (2 to 3 months) and the longest was in the 90-percent RH room (7 to 9 months).

The calibration procedure closely followed ASTM (1992) Standard D 4444-92. The moisture meter used was a Delmhorst[2] model RDX-1 set for two pins, species group A, and at 80°F (27°C) on the variable temperature scale, as received from the factory. Insulated pins were driven 0.5 in. (13 mm) into each wide face at two locations. A downward drift in the meter readings with time was noted after insertion of the electrode pins. To establish commonality, all readings were taken 3 s after the final thrust of the electrode pins. The four readings were averaged for each specimen. After equilibration and meter measurements, specimens were ovendried at 220°F (104°C) until constant weight.

Results

Correction Factors

Correction factors were determined by linear regression as stated in ASTM D4444-92, in which the meter reading is the dependent variable and true moisture content (MC) is the independent variable. The format is

$$MC_{meter} = a + bMC_{true}$$

where a and b are the regression coefficients. Results of the regression equations are shown in Figures 1 to 4, and the regression equations are as follows:

Celtis sp. (African celtis)	$MC_{meter} = -3.91 + 1.39MC_{true}$
Piptadeniastrum africanum (dahoma)	$MC_{meter} = -4.29 + 1.51MC_{true}$
Brosimum alicastrum (ramon)	$MC_{meter} = -0.903 + 1.16MC_{true}$
Vatairea lundellii (danto)	$MC_{meter} = -1.84 + 1.12MC_{true}$

Because the slopes of the regressions did not equal 1, the correction factors varied with moisture content and were calculated from the following:

$$C = MC_{true} - MC_{meter} = (MC_{meter} - a)/b - MC_{meter}$$

Correction factors for meter readings from 7 to 25 percent are shown in Table 1. These correction factors were applied after the temperature correction factor was made either internally by the meter circuitry or manually with the manufacturer's information.

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[2]The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

Meter Accuracy

Figures 5 to 8 give information about the accuracy of the moisture meter readings and their ability to estimate true moisture content. They show the 95-percent confidence intervals for true moisture content as a function of moisture meter reading. The lower and upper values of true moisture content were calculated from the regression equations at the lower and upper confidence limits of moisture meter readings at each relative humidity. The confidence interval was taken as the difference between the lower and upper calculated true moisture content limits. For example, from Figure 8, if the moisture meter reading for danto was 12 percent, there was a 95 percent chance that the true moisture content was between 11.4 and 12.6 percent. The size of the interval increased with moisture content and varied from a low of about ±0.1 percent moisture content for ramon at 6 to 7 percent moisture content to more than ±1.5 percent for celtis at high moisture content.

Meter Drift

A typical meter drift is shown in Figure 9 for celtis with an initial true moisture content of 19.9 percent. True moisture content decreased to 19.0 percent in about 20 s, and to about 18.5 percent in 90 s. The ASTM D 4444-92 specifies taking readings as soon as possible after driving in the pins. However, with the rapid drift soon after driving the pins, the reading could be somewhat arbitrary. Figure 10 illustrates the drift for celtis at 10 and 21 percent true moisture content in terms of percentage of the reading at zero time. Table 2 shows similar data for all species tested. Species and moisture content did not appear to have a large effect on the relative size of the drift.

Conclusions

For an electrical resistance-type moisture meter, correction factors for celtis, dahoma, ramon, and danto range from 0.8 to -4.2, 0.5 to -5.6, -0.2 to -2.7, and 0.9 to -1.1 percent moisture content, respectively, depending on the meter reading. Correction factors are added to the meter readings (corrected to 80°F (27°C)) between 7 and 25 percent moisture content. The 95-percent confidence intervals for true moisture content as estimated by moisture meter vary from ±0.2 to ±1.7 for celtis, ±0.2 to ±0.3 for dahoma, ±0.1 to ±0.7 for ramon, and ±0.2 to ±1.0 for danto. The rate of meter drift with time is rapid soon after pin insertion, and after about 2 min stabilizes to about 91 to 94 percent of the zero time reading.

References

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Pfaff, F.; Garrahan, P. 1984. Moisture content correction tables for resistance-type moisture meter. Report SP511E. Forintek Canada Corp., Ottawa, Ontario. 42 p.

Table 1—Species correction factors for an electrical resistance-type moisture meter[a]

Moisture meter reading (percent)	Correction factor (percent)			
	Celtis	Dahoma	Ramon	Danto
7	0.8	0.5	–0.2	0.9
8	0.6	0.1	–0.3	0.8
9	0.3	–0.2	–0.5	0.7
10	0	–0.5	–0.6	0.6
11	–0.3	–0.9	–0.7	0.5
12	–0.6	–1.2	–0.9	0.4
13	–0.8	–1.5	–1.0	0.3
14	–1.1	–1.9	–1.2	0.1
15	–1.4	–2.2	–1.3	0
16	–1.7	–2.6	–1.4	–0.1
17	–2.0	–2.9	–1.6	–0.2
18	–2.2	–3.2	–1.7	–0.3
19	–2.5	–3.6	–1.8	–0.4
20	–2.8	–3.9	–2.0	–0.5
21	–3.1	–4.3	–2.1	–0.6
22	–3.4	–4.6	–2.3	–0.7
23	–3.6	–4.9	–2.4	–0.8
24	–3.9	–5.3	–2.5	–0.9
25	–4.2	–5.6	–2.7	–1.1

[a]Correction factors are added to meter readings at 80°F (27°C).

Table 2—Decrease in true moisture with elapsed time after needle insertion, as estimated by moisture meter

Species	Initial MC (percent)	Percentage of original reading after elapsed time							
		0 s	5 s	10 s	15 s	20 s	30 s	60 s	120 s
Celtis	11	100	97.80	96.43	95.59	94.98	94.15	93.08	92.40
	15	100	97.69	96.37	95.49	94.88	94.06	92.85	92.13
	21	100	97.26	96.20	95.40	94.83	94.11	92.48	91.29
Dahoma	10	100	98.14	97.03	96.14	95.54	94.65	93.46	92.65
	14	100	98.87	97.84	97.09	96.50	95.79	94.77	94.12
	21	100	97.98	96.91	96.34	95.56	94.92	94.28	93.36
Ramon	22	100	97.92	96.68	95.79	95.39	94.55	93.40	92.29
Danto	18	100	98.16	97.03	96.32	95.84	95.19	94.16	93.24

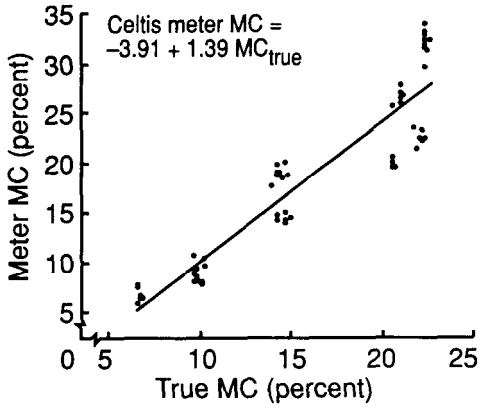

Figure 1–Linear regression of resistance moisture meter readings as a function of true moisture content for celtis at 80°F (27°C). Correlation coefficient = 0.882.

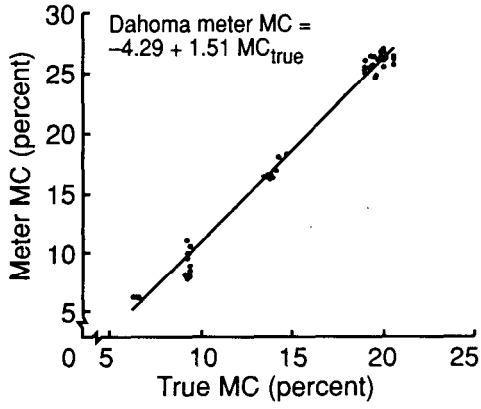

Figure 2–Linear regression of resistance moisture meter readings as a function of true moisture content for dahoma at 80°F (27°C). Correlation coefficient = 0.984.

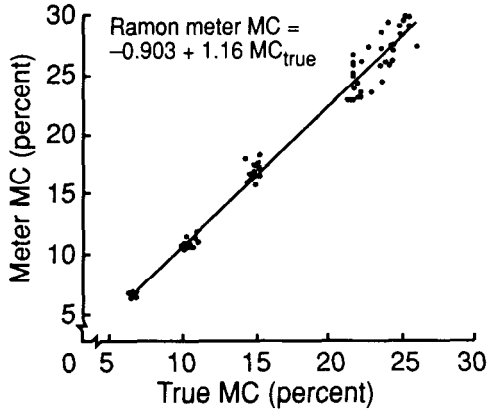

Figure 3–Linear regression of resistance moisture meter readings as a function of true moisture content for ramon at 80°F (27°C). Correlation coefficient = 0.985.

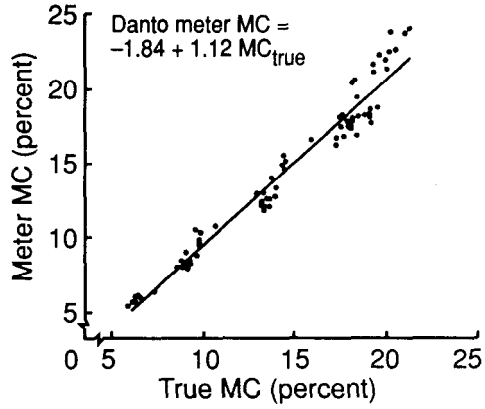

Figure 4–Linear regression of resistance moisture meter readings as a function of true moisture content for danto at 80°F (27°C). Correlation coefficient = 0.960.

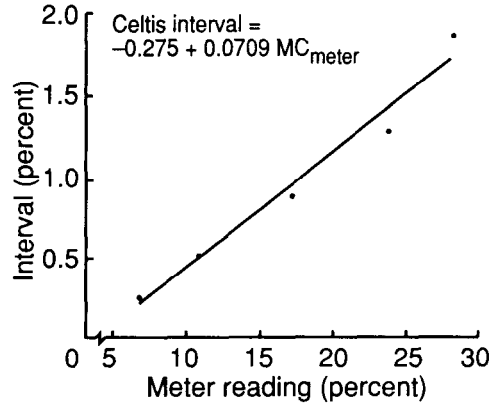

Figure 5–95 percent confidence interval for true moisture content of celtis as a function of moisture meter reading.

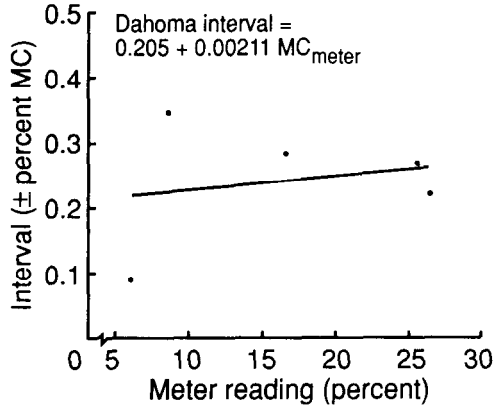

Figure 6–95 percent confidence interval for true moisture content of dahoma as a function of moisture meter reading.

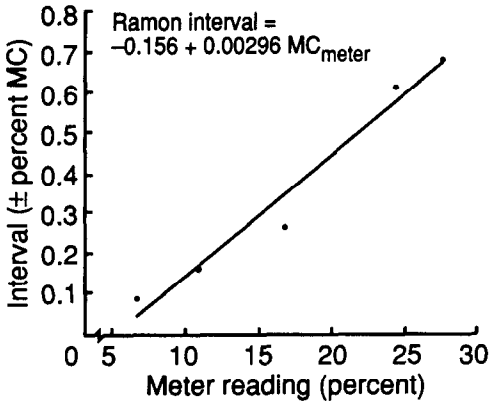

Figure 7–95 percent confidence interval for true moisture content of ramon as a function of moisture meter reading.

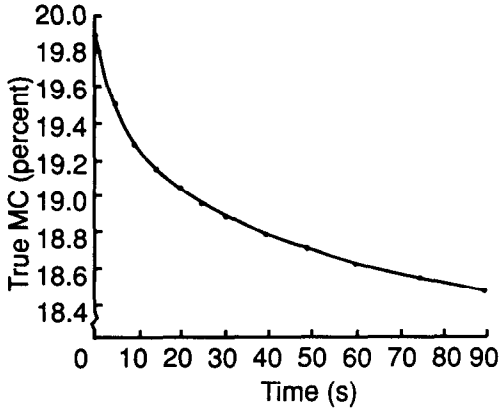

Figure 9–Time drift of true moisture content estimate of celtis.

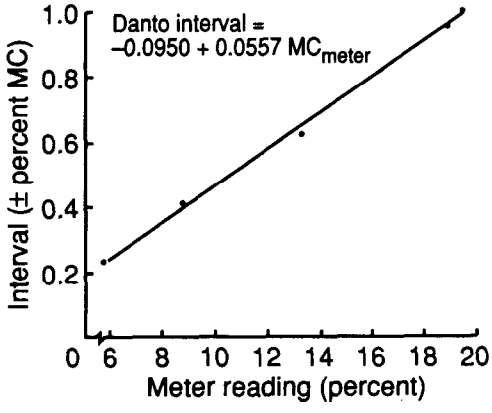

Figure 8–95 percent confidence interval for true moisture content of danto as a function of moisture meter reading.

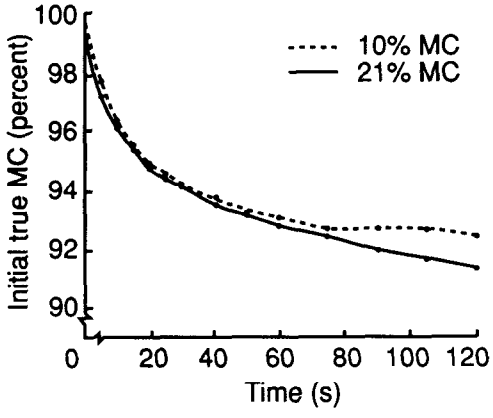

Figure 10–Time drift of true moisture content estimate of celtis in terms of percentage of true moisture content at zero time.

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