Technical Note

The Effect of Variables on Laboratory Termite Testing: Part II—Effect of Grain Orientation of Test Blocks

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Abstract

The effect of test-block grain orientation on laboratory termite tests using American Wood-Preservers' Association Standard E1-97 was evaluated using *Coptotermes formosanus*. This research revealed that testing of samples with the 6-mm direction in either the longitudinal or the tangential direction was appropriate. The E1 standard was subsequently modified to allow either.

Many variables play a role in the outcome or accuracy of laboratory termite test results. This contribution is the second in a multipart research program to evaluate the variables in American Wood-Preservers' Association (AWPA) Standard E1-97 (1997) including soldier:worker ratio (Lindsey et al. 2020), density and moisture content (Lindsey et al. submitted for publication [a]), wood species, block size, and test photoperiod (Lindsey et al. submitted for publication [b]). AWPA Standard E1-97 (1997) Section 2.4 covers block size and species, ring count, and other sample descriptors. Since opinions differ on sample orientation, this test was designed to address the orientation issue.

When looking at the grain direction, cutting a sample 6 mm in the radial direction could very easily produce samples that are inconsistent with respect to the earlywood and latewood growth rings. Termites are known to prefer the easier-to-digest earlywood to the harder and more resinous latewood (Behr et al. 1972).

Consistency among all test samples is very crucial to producing accurate results. As stated in the E1-97 standard, all samples for each test experiment should have the same growth ring count and come from the same parent board. In some tests, such as outdoor field experiments, it would seem more logical to randomize samples to yield groups with similar sample density distributions as is done with field test samples, such as stakes in AWPA Standard E7 (AWPA 2020). Field test samples are usually larger in size than those used in laboratory tests and are used to determine protection against other factors such as decay, termites and other insects, ultraviolet light, and leaching. In laboratory tests, such as those conforming to the AWPA E1 termite tests, the test-block sample size tends to be smaller and tests are shorter in duration than those found in typical field experiments. The objective of the following experiment was to test the impact of grain orientation on termite feeding.

Methods and Materials

The termites used in this test were the Formosan subterranean termite (FST, *Coptotermes formosanus* Shiraki). All termites were collected from one colony. Two 1-g samples of termites were counted to determine total number of termites and percentage of soldiers. In composite, 1 g of termites equaled 402 total termites with 4 percent soldiers. French-square bottles were filled with 120 mL (approximately 150 g) of screened and washed silica sand and 30 mL

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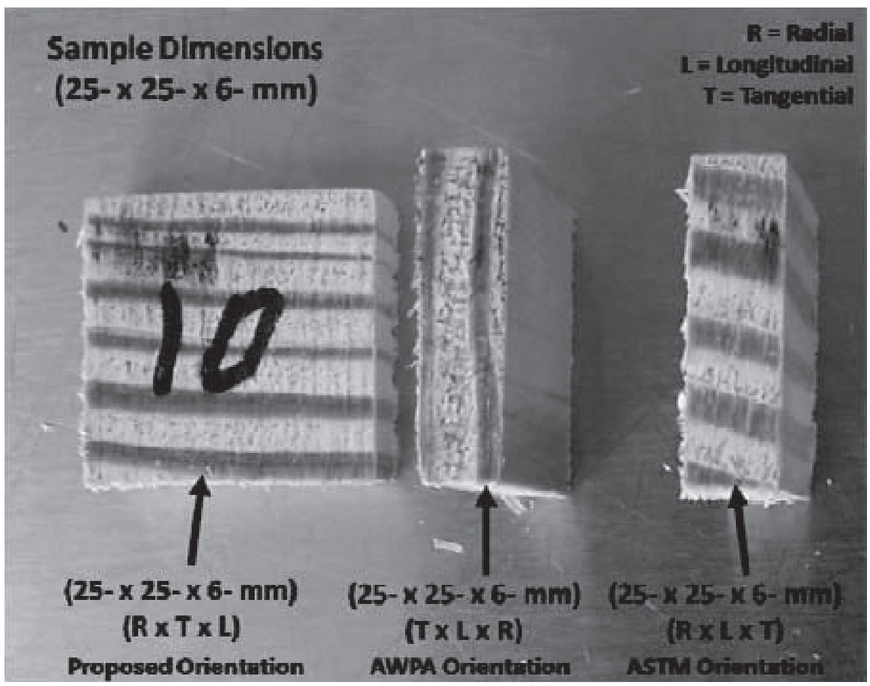
of distilled water 2 hours prior to test blocks being introduced. Untreated, defect-free, straight-grained southern pine (*Pinus* spp.) sapwood, selected according to the AWPA E1-97 standard (AWPA 1997) with the exception of grain orientation, was used in the tests. Experimental groups of approximately 1 g of the FST were added to French-square bottles to according to the E1 standard (AWPA 1997). The duration of the test was 28 days.

Data analysis was conducted using analysis of variance and means separation using Tukey's test ($\alpha = 0.05$). Ten replications for each grain direction (Fig. 1a) were tested.

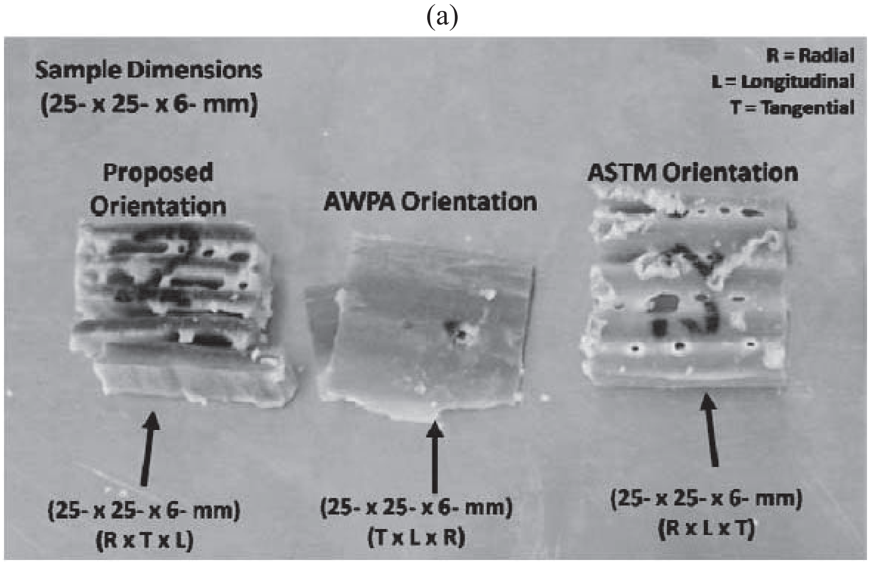
Results and Discussion

Descriptive statistics (Table 1) indicate conditions suitable for aggressive termite attack. A high weight-loss range among test samples was found for the grain orientation of 6 mm in the radial direction. Weight-loss values obtained within the 10 replicates of the standard orientation (tangential by longitudinal by radial) ranged from 70.0 to 36.6 percent with a mean of 45.1 percent.

For the other test groups, 6 mm in the longitudinal or tangential directions, the range difference was less than 6 percent weight loss. For 6-mm longitudinal-direction samples, the range was 36.4 to 30.6 percent with a mean of 33.5 percent (Table 1). The weight loss range for the 10 replicates of 25-mm square by 6 mm in the tangential direction was 29.5 to 35.2 percent with a mean of 33.0 percent (Table 1). Among test groups, there was no overall statistical difference between groups of samples with the 6-mm dimension cut in the longitudinal or tangential direction. Tukey's test indicated a statistical difference



(a)



(b)

Figure 1.—Grain orientation of samples (a) before and (b) after testing.

Table 1.—Descriptive percentage of weight loss statistics by grain orientation (25 by 25 by 6mm).

Parameter	% weight loss[a]		
	T × L × **R**[b]	R × T × **L**	R × L × **T**[c]
Mean[d]	45.1 A	33.5 B	33.0 B
SE	3.0	0.65	0.52
Median	44.0	34.0	33.0
SD	9.6	2.0	1.6
Minimum	36.6	30.6	29.5
Maximum	70.0	36.4	35.2
Replications	10	10	10

[a] T = tangential; L = longitudinal; R = radial; 6-mm direction in bold letters.

[b] Grain orientation required by American Wood-Preservers' Association (AWPA) Standard E1-97 (AWPA 1997).

[c] Grain orientation required by ASTM Standard D3345 (ASTM International 2004).

[d] Means with the same letter are not significantly different at $P = 0.05$.

when the 6-mm dimension was cut in the radial direction compared to the tangential or longitudinal directions.

In some cases, cutting samples 6 mm in the radial direction yielded samples with more earlywood than latewood, which led to an increase in weight loss compared to the other orientations. Some samples yielded pieces with more latewood than earlywood, which produced the opposite effect. This inconsistency in samples can be seen in Table 1, with a higher standard error of the mean of 3.0 in the radial direction compared with 0.65 and 0.52 for the other grain orientations. Visually, it was easier to maintain the same proportion of earlywood and latewood. Additionally, it was easier to obtain more consistent results in samples cut 6 mm in the longitudinal or tangential directions (Fig. 1). The lower error with these two orientations suggests that 10 replications should be used. Data from this test method often comprise one of the few pieces of data submitted to support standardization for a preservative against FST, so potential error should be minimized.

Conclusions

The results suggest that the best grain orientation should be either 6 mm in the longitudinal or tangential direction. AWPA Standard E1-97 has stated 6 mm in the radial direction since its inception in 1972 (AWPA 1972). Due in part to this research, AWPA Standard E1-97 was changed so that the current standard AWPA E1-17 (AWPA 2019) now specifies 6 mm in either the longitudinal or the tangential directions. A change from 5 to 10 replications has not been made.

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