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# NEW TERMITE AND MOULD TESTING METHODOLOGIES FOR WOOD-BASED PRODUCTS

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## SUMMARY

A host of new treatments for protecting engineered wood products against biological elements are being developed. The major impetus for this is the need for better protection of these wood-based products as their use expands to areas exposing them to greater biological hazards. This has created the need to examine existing testing methodologies and develop new experimental designs to obtain useful data in a reasonable timeframe and more accurately predict their performance for "in service" conditions. This paper discusses testing methods including both conventional and novel techniques, which are being used to determine efficacy of treatments applied to wood-based products for mould and termite resistance. Pitfalls of testing methods are summarised.

## INTRODUCTION

New testing methods are being developed and existing testing methods are being modified to better assess the quality of new preservative treatments for engineered wood products. These new treatments, designed to be environmentally friendly and less toxic to humans, require extensive validation before entering the market. New or modified testing procedures therefore, are being developed to assure treatment efficacy, final product quality, and a reduction in testing duration. This can only be done, however, if proper testing methods can provide appropriate data to determine the long term efficacy of treated wood-based products. The need for shorter testing times results from increasing use of engineered wood products in construction requiring new treatments for these materials. This is compounded by the homeowner's desire for new environmentally sensitive and safe preservatives.

Emphasis in the state of Louisiana has been concentrated on developing testing methodology for the Formosan subterranean termites (*Coptotermes formosanus*, Shiraki) and resistance to mould growth on wood-based products. An invasive species, the Formosan subterranean termite, *Coptotermes formosanus* Shiraki, is believed to have been introduced in the southern United States from East Asia around the end of World War II. Its presence was not detected until 1966 in Louisiana. At this time it was disclosed in one New Orleans survey that 5% of the homes and 9% of the trees were already heavily infested with this invasive species (Spink, 1967). Infestations are well-established in Hawaii, Texas, Louisiana, Florida, and South Carolina due to their important ports for returning military ships. The Louisiana cities of New Orleans and Lake Charles/ Westlake appear to have the largest concentration of colonies and have suffered tremendous losses. Economic losses in New Orleans alone have been estimated to be $350 million per year due to treatments, repairs, defaults on loans, and collapse and demolition of structures. This termite is now considered the most destructive insect in Louisiana and has also been described as the most important structural pest of the new millennium (Hunter, 2000). As a result, actions are being taken to encourage the use of chemically treated wood products for house construction in the South. A major problem, however, is the availability of treated engineered wood products especially oriented

strandboard, medium density fibreboard, and particleboard that are not suitable for waterborne impregnation.

In addition to termite infestations, the hot humid conditions in the southern United States promote mould growth in structures. Due to journalistic reports of mould causing illnesses, the US public is becoming increasingly concerned with potential health effects from mould in their homes. This is a major driving force to develop new mould treatments and hence better mould testing methodologies.

## TESTING TERMITE EFFICACY

### Laboratory Testing

Laboratory tests or screening tests for resistance to insect infestation is a relatively rapid process normally lasting four weeks. The standard used is AWPA Standard E1-97, Standard Method for Laboratory Evaluation to Determine Resistance to Subterranean Termites (AWPA 2002). In essence, this test subjects a test sample to 400 termites for four weeks under controlled conditions. Analysis consists of determining termite mortality, sample weight loss, and a subjective rating of degradation due to termite attack. Degradation ratings are based on a scale from 0 to 10 with 0 being failure; 4 heavy attack; 7 moderate attack, penetration; 9 light attack; and 10 being sound, surface nibbles permitted. These laboratory tests work well when the standards are followed. Engineered wood products may require extra caution when testing. Due to high moisture conditions during testing, a composite panel subject to thickness swell may delaminate during testing. This may make it difficult for a proper rating to be obtained since it may be difficult to determine how much damage is done by termite activity. With experience and correlation with weight loss data, treatment efficacy can be determined. Due to delamination, certain treatments may also be more prone to leaching, therefore, samples may require foil between the sample and moist sand.

Several other pitfalls in laboratory testing can also occur. If termites are not kept healthy in the laboratory they may become weak. If they are then used, the product may have higher ratings than the treatment deserves. This can be indicated, however, by ratings of the control samples. It is important, therefore, to always use a common control species for each trial, regardless of material being tested so a comparison can be made. The most common is southern yellow pine sapwood. Other pitfalls that can occur include initial strength of termite colonies, methods of termite collection, laboratory conditions for maintaining termites, sample preparation, mould growth in testing jars, oxygen levels in testing jars, and termite handling during setup.

### Field Testing

Field testing for termite resistance is designed to develop information on treatment efficacy and durability, but may require a 3 to 15 year testing period. One reason for this long duration is experimental procedure. Current termite field tests require time to assure termites have had access to the test specimens. Most commonly, an area is located that has existing termites. Samples are placed in this area and data collection begins after samples are “hit” or attacked. This time is variable since there is little control over direct termite access to the samples. In addition, the probability that each sample will be hit uniformly or with the same intensity is low. The combined effect of these issues, therefore, requires longer testing times.

Two testing methods have been developed to address these issues. One is to develop a field site that can be enhanced with directed termite activity and the second is the use of a bait crate system for an intense initial analysis.

Enhanced Field Site

Efforts by Louisiana State University Agricultural Center and Mississippi State University research scientists realised that a field test site on the United States mainland for *C. formosanus* would significantly decrease the time required to complete viable projects. From research with *C. formosanus* in Hawaii, it became apparent that conducting replicated studies in the field required either placing test materials directly adjacent to known *C. formosanus* nest sites or attracting the termites to a test site area (Williams, Amburgey, and Sanders, 1999; Amburgey, Sanders, and Bell, 2002). Based on work in Australia with other species of *Coptotermes*, *C. formosanus* likely could be directed from their nest sites to test units by digging trenches in a spoke-like pattern from the nests; lining the trenches with non-treated, susceptible bait wood; filling the trenches; and placing test unit replicates on top of the trenches (Peters and Fitzgerald, 1997).

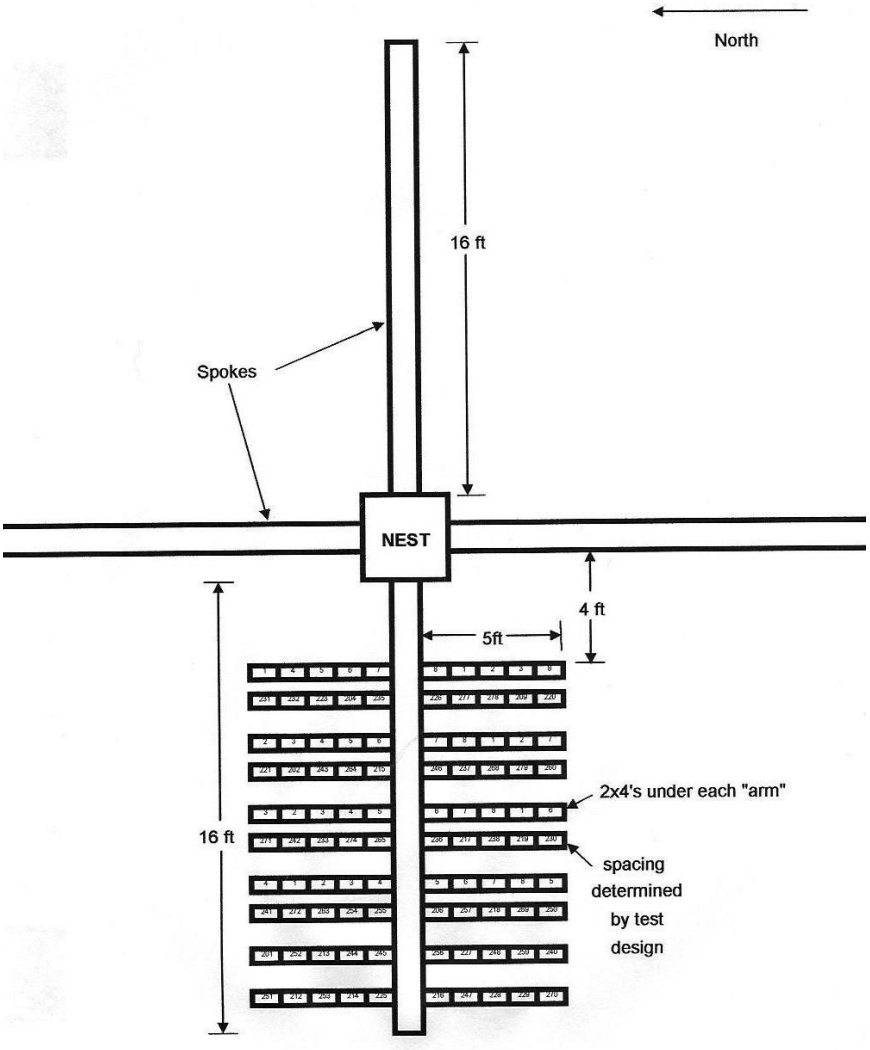


*Figure 1: Schematic of enhanced termite field site.*

Based on this information and having a location on LSU AgCenter property that contained *C. formosanus,* it was decided to develop a field site with more control over termite access to the test specimens (Smith, et al, 2003). This site, approximately 6 hectares in size is large enough to "seed" the area at regular intervals with *C. formosanus* colonies of known origin. The site also has low biocide levels in the soil and water and is secure from vandals or others who may purposely or inadvertently disrupt field test units since it is gated university property. Nest locations were laid out such that the centres are approximately 30 meters apart. Each nest location consists of a central hole approximately 0.7 meters deep and 1 meter in diameter with four 5 meter-long trenches or "spokes" radiating from the nest site at 90 degrees to one another. Two 20x20-cm to 25x25-cm timbers were placed upright in the holes at the nest sites to provide termites a place to go above ground during wet periods. Four to eight bait crates (as discussed below) of *C. formosanus* collected locally were introduced into each nest site next to the timbers and surrounded by seasoned timber sections. The nest holes were filled with sand. Moisture control at each nest site consists of a trench filled with sand to drain the nest during periods of heavy rainfall, and each site can be irrigated during dry periods. Weather parameter data is also collected.

The "spokes" consist of two southern pine sapwood 2 x 4's (3.8 x 8.9 x 510 cm) placed side by side. Before being filled, the end of each spoke was marked with a non-biodegradable stake and non-treated pine monitor stake. In addition, depending on the testing protocol being used, additional "spokes" can be placed perpendicular to each spoke which will allow a greater area of controlled termite foraging. This will enhance the probability of equal termite pressure on each sample being tested. Bait wood between spokes may be placed in different configurations. A general schematic of this set-up is shown in Figure 1. The site is divided into distinct areas to minimise the probability that one type of study will influence the results obtained in another. This site is used for: (1) demonstration projects; (2) test structures, (3) in-ground tests to evaluate preservatives (stake tests) or termite baits, (4) above-ground preservative comparative tests and/or building component durability tests, and (5) basic termite biology / behaviour / movement studies. Tests involving non-repellent termiticides and soil treatments are considered under special circumstances because these may completely destroy an established nest.

Bait Crates

A bait crate system is used by LSU AgCenter to capture termites (Smith *et al,* 2002). These crates, composed of a matrix of wood pieces, are placed in known areas with high concentrations of Formosan subterranean termites. They are left from three to six weeks to allow termite infestation of the wood. They are then removed and taken to a laboratory where the termites are extracted for use in laboratory choice and no-choice tests. An example termite bait crate is shown in Figure 2.

Each crate will hold 48 4x4x28 cm samples. Samples are numbered, measured for dimensions and weighed. In addition, the moisture contents of each sample are determined to allow an oven dry weight to be calculated. The crate baits are taken to an active site and buried. Depending on the testing protocol, one crate will be removed after an initial period of three to 10 weeks and the second after doubling or tripling the initial crate time. If there is a lack of sufficient activity after the initial testing period, the crate will be replaced for an additional period to be determined at that time. The removal of the second crate is then determined based on the analysis of the first crate.

Crates are examined in the laboratory and termites extracted from the material. Termite free samples are examined for termite damage and rated the same as the laboratory tests on a scale from 0 to 10: 0 being failure; 4 heavy attack; 7 moderate attack, penetration; 9 light attack; and 10 being sound, surface nibbles permitted. In addition, samples are oven dried, weighed and weight loss determined.

This test procedure provides a basis of efficacy based on the most severe conditions. It can be used for short term analysis of treatments subject to intense ground attack. Pitfalls are lack of information on decay resistance, long term leaching or treatment degradation, and limitations for repellents if the controls are not attacked.

*Figure 2: Bait crate for collecting termites or testing products.*

## TESTING FOR MOULD EFFICACY

Extensive testing of mould efficacy for wood-based products in the United States is relatively recent. Testing procedures, therefore, are still being developed and new methodologies will be continuing. Currently there are three basic procedures being used in the laboratory. These consist of a Petri dish method, a covered tub method and a controlled chamber method.

The simplest and least severe is the Petri dish method. This consists of testing a treatment or treated product in a Petri dish containing a known mould. This method is used most often for initial screening of treatments.

The covered tub method developed by Michigan Technological University is a more severe test. This consists of taking treated, untreated, and control samples and placing them in a plastic covered tub. The samples are placed horizontally on a screen suspended above a body of water. The container is closed and placed in a warm room to assure high humidity conditions. Samples are periodically examined to determine amount of mould growth.

Inoculation of the samples is done through natural means, i.e. existing airborne spores. This test is simple to perform but is limited to mould spores currently present when the test is set up. It is a good test for a relatively quick initial treatment analysis.

The most severe method is the controlled environmental chamber method. This method is currently in draft form and has been proposed as an AWPA Standard titled: "Standard Method of Evaluating the Resistance of Wood Product Surfaces to Mold Growth". This Standard is based on the ASTM Standard Test Method D 3273 – 00, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber" (ASTM 2002).

*Figure 3: Environmental chamber for testing wood-based products for resistance to mould.*

In essence, this Standard provides an evaluation method for assessing the resistance of surfaces of wood products most commonly intended for use in interior environments where unintentional mould growth conditions may occur. Samples of wood products are exposed in an environment chamber where temperature and relative humidity are controlled to provide ideal conditions for the growth of moulds. The chamber and samples are inoculated with specified moulds, and circulating air within the chamber continually subjects samples to spores for the duration of the test. Pure cultures of *Aureobasidium pullulans* (d. By.) Arnaud ATCC 9348; *Aspergillus niger* v. Tiegh. ATCC 6275; *Penicillium citrinum* Thom ATCC 9849; and *Alternaria tenuissima* group (Kunze) Wiltshire Ftk 691B are used to prepare inoculums for soil in the environment chamber and for application to sample surfaces. The method is non-sterile, and therefore moulds from the air or soil may be present and compete with the inoculated moulds for colonisation on surfaces of test products. Samples are removed from the chamber and evaluated for mould growth on the sample surfaces every two weeks for eight weeks. Each sample is assigned a rating for extent and intensity of mould growth. The rating system ranges from 0 for no visible growth to 5 for 100% coverage with intense or colour growth obscuring greater than 70% of the sample colour. Resistance to mould growth is evaluated relative to reference products and unprotected pine sapwood. Pine sapwood is included as an untreated control substrate to indicate viability of moulds in the test

chamber and severity of growth conditions. This is important as mould intensity appears to affect the amount of mould that will grow on nearby samples. Data reported should therefore include number of samples per chamber and location of test specimens with respect to controls. An environmentally controlled mould chamber is shown in Figure 3.

Some field testing procedures for mould resistance are underway and comprise a number of methodologies with the most common being a stack test. A stack test is done by solid piling treated and untreated wood-based products and examining for mould growth. The stack may or may not be covered in plastic to simulate shipping and storage conditions. To test long-term effectiveness, testing structures will need to be developed to simulate above ground in-wall conditions that are exposed to higher moisture and humidity. Pitfalls to be aware of include the large number of mould species that may or may not be included in the test, test specimen history, longevity of treatment chemical, product attributes that may affect treatment chemistry, testing environment, and researcher safety in handling specific moulds.

## CONCLUSIONS

The US public's awareness and concerns have increased with respect to termite attack and mould growth on wood-based products. This combined with the desire for increased availability of environmentally friendly treatments has created the need for modified testing methodologies for engineered wood products. Testing methods are therefore being developed to better assess new treatments for wood-based products through enhanced field sites, bait crate testing for termites and environmental testing chambers for mould resistance. These methods provide high quality data that can be provided in less time than conventional testing. Care must be taken, however, as inaccurate data can be obtained if protocols are not followed closely.

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