InterNACHI free online course is at http://www.nachi.org/wdocourse.htm.

Wood-Destroying Organism Inspection

The purpose of the course is to define and teach good practice for:

1) conducting a wood-destroying organism inspection of a building; and
2) performing treatment applications for the control of wood-destroying organisms.

This course provides information, instruction, and training for the wood-destroying organism inspector and commercial pesticide applicator studying to become certified. The student will learn how to identify and report infestation of wood-destroying organisms that may exist in a building using a visual examination. The student will learn the best practices for treatment applications to control infestation. The course is designed primarily for wood-destroying organism inspectors, building inspection professionals, and commercial treatment applicators.

STUDENT VERIFICATION & INTERACTIVITY

Student Verification

By enrolling in this course, the student hereby attests that he or she is the person completing all course work. He or she understands that having another person complete the course work for him or her is fraudulent and will immediately result in expulsion from the course and being denied completion. The courser provider reserves the right to make contacts as necessary to verify the integrity of any information submitted or communicated by the student. The student agrees not to duplicate or distribute any part of this copyrighted work or provide other parties with the answers or copies of the assessments that are part of this course. Communications on the message board or forum shall be of the person completing all course work. If plagiarism or copyright infringement is proven beyond a reasonable doubt, the student will be notified of such and expelled from the course and/or certification revoked.

Interactivity

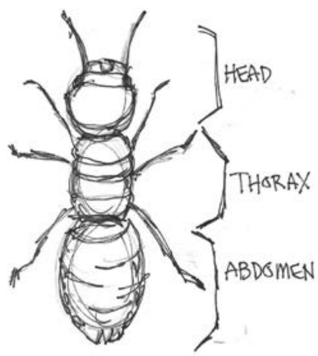
Interactivity between the student and the course provider is made by the opportunity to correspond with the instructor via email. To ask questions at any time prior to, during or after the taking the course, the student can contact the course instructor via email. Students will receive a timely response within 24 hours during the workweek and by close of business on Monday for questions received over a weekend.

The student can join in the conversation with other students of this course, by visiting the course's online forum dedicated to the subject matter of the course at www.nachi.org/forum/f25/wood-destroying-organism-inspection-course. Students are free to pose questions and comments there and join in the conversation with other students. The thread will be monitored by the course instructor.

Contact

Contact InterNACHI's Director of Education Ben Gromicko via email at ben@internachi.org.

PREFACE



This course provides information for the wood-destroying organism (WDO) inspector and commercial pesticide applicator studying to become certified.

To become a certified inspector or applicator, a candidate typically must pass both a general standards exam and an examination based primarily on the material presented in this course and in the study materials required by the state in which the candidate conducts business.

Acknowledgments

The **International Association of Certified Home Inspectors (InterNACHI)** and **NACHI.TV** would like to thank the U.S. Environmental Protection Agency, the Ohio Department of Agriculture, and the Arkansas Department of Agriculture. Their time, effort and expertise are greatly appreciated.

Special thanks goes to the Ohio State University Cooperative Extension, the Arkansas State University Cooperative Extension, the U.S. Department of Agriculture, entomologist Dr. John Hopkin, University of Arkansas, and the librarians at the EPA Region 8 Technical Library Services in Denver, Colorado.

Information about WDO has been accumulated from direct observations, scientific literature, and anecdotes from others. Information from these sources blurs together quickly and, consequently, unique ideas are rare in society. Credit for sources of information on inspecting and controlling WDOs must go to:

Members of the International Association of Certified Home Inspectors; Land Grant University Extension and research workers; most entomologists who pioneered this work; those who kept training and research alive during the period when the success of synthetic organic pesticides preempted nearly all but control evaluations from the 1940s to the 1960s, and those who persist today; pest control industry workers who held training sessions nationally, regionally and locally where information was disseminated among the experienced and provided to the inexperienced; Environmental Protection Agency personnel who molded modern training and influenced the need for national uniformity in training requirements; state regulatory personnel who cooperated with universities and industry and who strongly emphasized the importance of training; and the few textbook authors in the United States and England who compiled the reference data in the understandable and usable form that allows urban pest management practitioners to be professionals.

Information in this course can also be found in training manuals for commercial WDO applicators developed and publications by the Oklahoma Cooperative Extension Service, Division of Agricultural Sciences and Natural Resources, Oklahoma State University; Texas Agricultural Extension Service, the Texas A&M University System; and University of Nebraska Cooperative Extension; and the University of Nebraska-Lincoln. Also, special thanks go to Dr. Jim T. Criswell, Pesticide Coordinator, Oklahoma State University, Oklahoma Cooperative Extensive Service, Dr. Roger E. Gold, professor and Extension entomologist; Harry Howell, assistant research scientist; Dr. Don L. Renchie, Extension assistant professor; Grady J. Glenn, research assistant; all of the Texas A&M University system; and Murray Walton, staff inspector, Texas Structural Pest Control Board, Dr. Clyde L. Ogg, Extension educator, and Larry C. Schulze, Pesticide Education Specialist, University of Nebraska Cooperative Extension.

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Disclaimer

The information given herein is supplied with the understanding that no discrimination is intended and no endorsement by the International Association of Certified Home Inspectors or NACHI.TV is implied. The agri-chemical recommendations herein are consistent with current federal and state pesticide labeling as of the date of publication. Revisions in labels can occur at any time. For your safety, before using any recommended pesticide, always read the product label.

- The course author is Benjamin Gromicko, ben@internachi.org. Comments and suggestions are appreciated.

- For InterNACHI's other online courses, visit http://www.nachi.org/education.htm.
- Advanced online training videos can be found at http://www.nachi.org/advancedcourses.htm.
- HVAC Training is available online at http://www.nachi.org/hvacclass2008.htm.
- Mold Inspection Training is available online at http://www.nachi.org/videomoldcourse.htm.

STATE CREDIT

If you are intending to take this course to receive credit from your state's Department of Agriculture, contact InterNACHI's Director of Communications Lisa Endza via email at lisa@internachi.org or by calling 303.502.6214.

For students in Oregon:

Please contact InterNACHI's Director of Communications Lisa Endza for assistance in receiving state credit: **lisa@internachi.org** or 303.502.6214.

For Nevada Custom Pesticide Applicators:

- This training is for educational purposes only (Pesticide Continuing Education Units [CEUs]) and should not be used for examination purposes.
- Upon completion of this training, a Pesticide Applicator will earn 2 Law CEUs and 10 General CEUs for a total of 12 CEUs. All Chapters must be completed and a passing grade earned on all quizzes and final exam before CEUs will be earned.
- Regarding Chapter 21: Laws Concerning WDI: In this chapter, the Ohio Department of Agriculture is used as an example. So, when Category 10b is referenced, this is actually category C4 in Nevada. Nevada Wood-Destroying Pest inspection Reporting Regulations can be found at in NAC 555.430 (http://www.leg.state.nv.us/ NAC/NAC-555.html#NAC555Sec430) .
- Regarding Chapter 22: Training and Licensing Requirements: The information presented greatly differs from Nevada's licensing requirements. The Nevada Department of Agriculture suggests that you refer to NAC 555.270 through NAC 555.397 (http://www.leg.state.nv.us/ NAC/NAC-555.html#NAC555Sec270) for Nevada-specific applicator licensing requirements (examinations), business licensing, insurance requirements, license renewal requirements and fees.
- Regarding Chapters 23 (The Real Estate Transaction) and 24 (Guidelines for Completing the NPMA-33 Form): In both chapters, the NPMA-33 form is referenced. Nevada **DOES NOT ACCEPT** this form for any real estate transactions in the state. The State of Nevada has developed their own form entitled *Wood-Destroying Pest Inspection Report*, which is required to be completed (this is noted in Chapter 23). The Nevada Department of Agriculture suggests that

you become familiar with correspondences with HUD on this issue. The NDOA has made these correspondences available on their website at: http://agri.nv.gov/AGRI_ FHA_VA_HUD.htm

For Nevada-Certified Applicators (Commercial or Private Applicators):

- **THIS TRAINING DOES NOT QUALIFY YOU TO DO ANY KIND OF WOOD-DESTROYING INSPECTIONS. ONLY LICENSED NEVADA CUSTOM APPLICATORS CAN CONDUCT INSPECTIONS ON BUILDINGS. DOING SUCH INSPECTIONS OR COMMENTING ON ANY WOOD-DESTROYING ORGANISM WILL PUT YOU IN VIOLATION OF NEVADA REVISED STATUTE (NRS) 555.285** (http://www.leg.state. nv.us/nrs/NRS-555.html# NRS555Sec285).
- This training is for educational purposes only (Pesticide Continuing Education Units [CEUs]).
- Upon completion of this training, a Pesticide Applicator will earn 2 Law CEUs and 10 General CEUs for a total of 12 CEUs. All chapters must be completed and a passing grade earned on all quizzes and the final exam before CEUs will be awarded.
- Regarding Chapter 21: Laws Concerning WDI: In this chapter, the Ohio Department of Agriculture is used as an example. So, when Category 10b is referenced, this is actually Nevada certification category 7c. Nevada certification category 7c Structural Pest Control DOES NOT include inspections.
- Regarding Chapter 22: Training and Licensing Requirements: The information presented greatly differs from Nevada's certification requirements. The Nevada Department of Agriculture suggests that you refer to NAC 555.600 through NAC 555.700 (http://www.leg.state.nv.us/ NAC/NAC-555.html#NAC555Sec600) for Nevada-specific applicator certification requirements (examinations), certification renewal requirements and fees. For certification, business licensing and liability insurance is not required.
- Regarding Chapters 23 (The Real Estate Transaction) and 24 (Guidelines for Completing the NPMA-33 Form): In both chapters the NPMA-33 form is referenced. Nevada **DOES NOT ACCEPT** this form for any real estate transactions in the state. The State of Nevada has developed their own form entitled *Wood-Destroying Pest Inspection Report*, which is required to be completed (this is noted in Chapter 23). For Nevada-Certified Applicators this is a moot point, as you are not allowed to fill out any kind of inspection form.

Be sure you have read the above. If you understand and **AGREE**, please click "**NEXT**" at the bottom of this page.

PREFACE: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

Taking the course based upon the information contained in this course/training manual does not make you certified by your state.

- False
- True (correct)

The course and the manual are approved by the University of Ohio and the U.S. Department of Agriculture.

- True
- False (correct)

CHAPTER 1: INTRODUCTION

Wood is a biological material. If protected from moisture and insect attack, it can last for centuries. When wood is not properly protected, however, it will succumb to biological processes that decompose wood: insects that eat the wood or fungi that cause rot and decay. The most damaging insects that attack structural wood are termites. Their activity results in damage and control costs that exceed $1.5 billion per year nationally. Beetles are the next important group of insects that attack wood, while bees, wasps and ants are third in importance, depending on geographical location. Wood-inhabiting fungi are another group of organisms that occasionally cause problems.

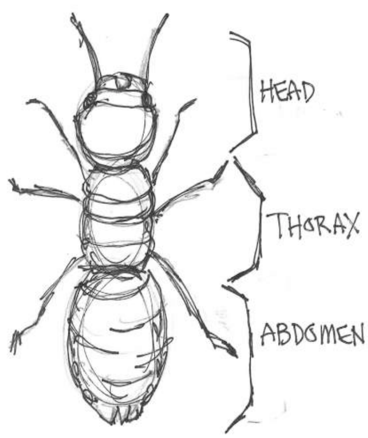


Figure 1. A termite worker, with the three body regions depicted. (Illustration courtesy of Ben Gromicko)

Reportable Wood-Destroying Insects

The insects discussed in this course/training manual are required to be reported on the NPMA-33 inspection form in most states. The wood-destroying insects that must be reported include subterranean termites, powderpost beetles, carpenter ants, carpenter bees, and drywood termites.

Correct identification of these insects and others is important not only for an accurate inspection, but also for reducing the liability resulting from the misdiagnosis of a problem.

It is important to understand insect biology because it greatly determines where a wood-destroying insect is most likely to be found in a structure. As a WDO inspector, you should expect to receive a variety of insect specimens from customers. Hence, it behooves you to have a general knowledge of insects.

The General Structure of Insects

An insect's skeleton is on the outside of its body and the muscles attach inside; hence, it is known as an exoskeleton. As an insect grows, it sheds its exoskeleton, which is made of chitin. This process is known as molting. Some termite bait toxicants kill termites by interfering with the molting process.

Insect Development

Insects develop from egg to adult by a process known as metamorphosis. In some insects, the developmental stages are egg to nymph to adult. This type of metamorphosis is known as gradual metamorphosis. Most of the insect's growth occurs in the nymphal stage. The nymphs usually look like small versions of the adult. Termites are an example of an insect that undergoes gradual metamorphosis.

Figure 2. A termite worker

All insects share a number of characteristics, including a segmented body with three distinct regions (the head, thorax and abdomen); one pair of antennae; and three pairs of legs. The head bears the eyes, antennae and mouthparts. The thorax bears the appendages for locomotion, including legs and wings (if present). Wings occur in one or two pairs and are present only in the adult stage. Immature insects may have evidence of developing wings, such as wing buds or wing pads, but immatures never have fully developed wings. The abdomen typically has no appendages except at the tip; abdominal appendages often are sensory or used in mating/reproduction.

Some insects develop by a process known as complete metamorphosis. The insect egg hatches into a larva that then molts several times before becoming a pupa, which finally molts into an adult. In this type of metamorphosis, the larval and pupal stages look and behave much differently than the adult. Examples of insects with complete metamorphosis include ants, bees and beetles.

Insects are cold-blooded, so their body temperature very closely follows the temperature to which they are exposed. Their development rate slows considerably in cold conditions. During the winter, many insects become inactive and hibernate in a protected site so they can survive the cold.

CHAPTER 2: BIOLOGY

The Biology of Insects and Termites

Living things are divided into the plant kingdom, the animal kingdom, and several smaller kingdoms of microscopic life. Insects are part of the largest group in the animal kingdom: the phylum *Arthropoda.*

Arthropods include spiders, mites, ticks, millipedes, centipedes, crabs, shrimp and insects. The class *Insecta* is distinguished from the other arthropod classes by the three body regions: head, thorax and abdomen. The head bears a single pair of antennae, the thorax bears three pairs of legs and usually wings, and the abdomen contains most of the digestive system and the reproductive organs.

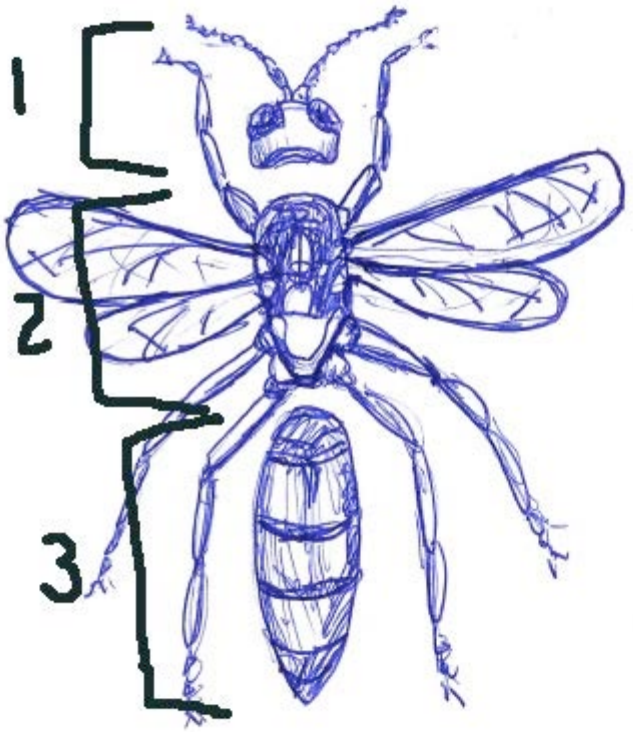


Figure 3. The three principal regions and parts of an insect's body, as shown on the paper wasp: 1) head; 2) thorax; and 3) abdomen (Courtesy of Ben Gromicko)

Other Divisions Used in Classification

Classes of arthropods - insects, for example - are divided into orders. These are distinct groups whose members look very much alike (e.g., the order of moths and butterflies, or the order of beetles).

Orders are subdivided into families made up of related species. Species of animals can be thought of as specific kinds of animals. Very closely related species are grouped together in a genus. Species or types of animals (and plants) are given scientific names that always consist of two words - the first word is the genus name (the first letter is always a capital); the second is the species name (always lower case). Both are written in italics or underlined (e.g., Musca domestica). Well-known species also usually have non-scientific names, called "common names" (e.g., "housefly").

Growth and Development

Growth

The arthropod body is confined in its exoskeleton. This outer covering can expand only a little at pliable or soft places. It does not grow continuously. Arthropods grow in stages. They form a new, soft exoskeleton under the old one, then shed (or molt) the old one. The new skeleton is larger and allows the animal to grow. The new exoskeleton is white at first, but it hardens and darkens in a few hours. After the molting process, which usually takes place in hiding, the arthropod resumes its normal activities.

Development

Most arthropods hatch as tiny individuals and grow by molting, usually keeping the same appearance until they become adults. However, a spectacular and very important exception occurs in the class *Insecta*. The insect class is divided into groups according to the way the insects change during their development. This change is called by the technical term metamorphosis, which means "change in form." Three main types of metamorphosis have been identified.

Group 1: Simple Metamorphosis

This group, including the order of silverfish, makes no drastic change in form from juvenile to adult. They simply hatch and grow larger by molting periodically. Only a few orders belong to this group.

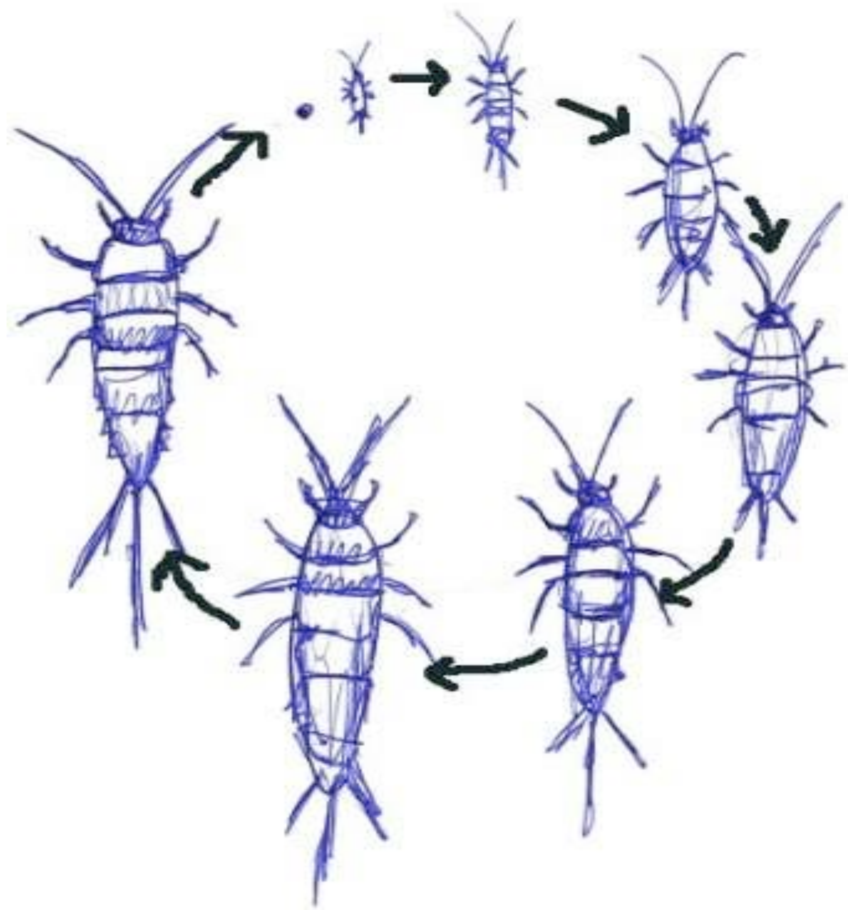


Figure 4. Development by simple metamorphosis using the example of a silverfish (Courtesy of Ben Gromicko)

Group 2: Gradual Metamorphosis

In this group (including termites, cockroaches, crickets, grasshoppers, boxelder bugs, earwigs, etc.), individuals hatch from the egg only partially resembling the adults. The immatures, or nymphs, do not have wings. Winged insects are always adults. Insects in 14 orders develop in this way.
Some of these orders have many species and include many pests. Nymphs and adults are often found together and usually eat the same food.

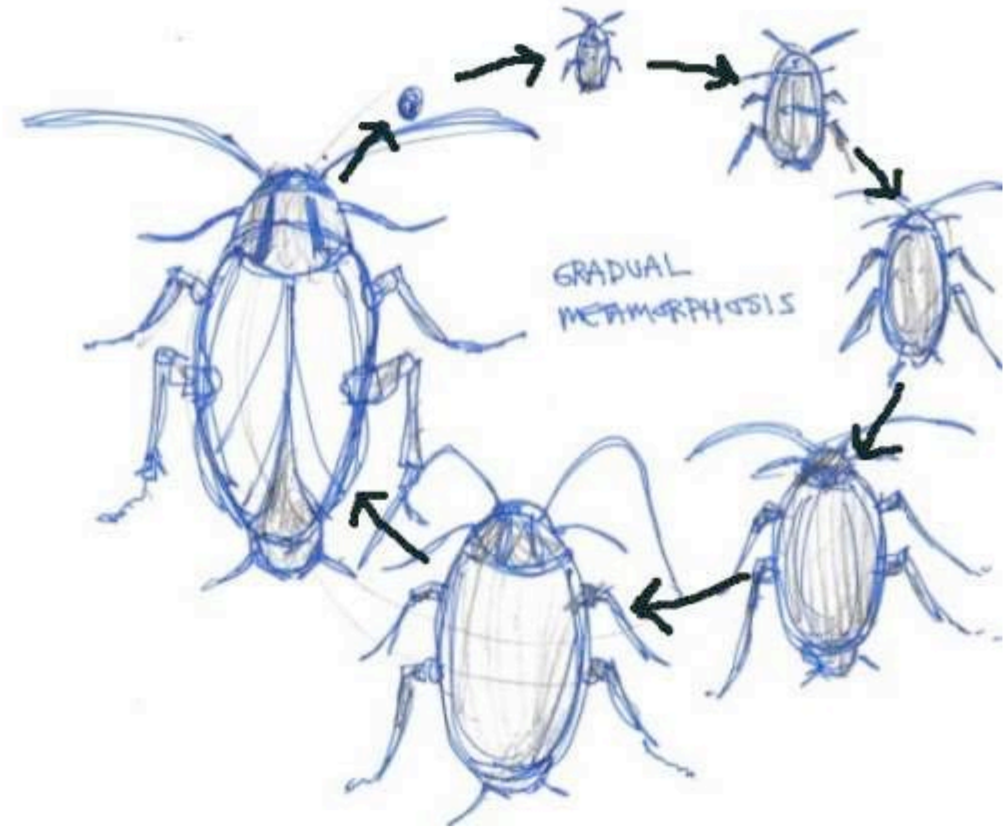


Figure 5. Development by gradual metamorphosis using the example of a cockroach (Courtesy of Ben Gromicko)

Group 3: Complete Metamorphosis

Insects that develop by complete metamorphosis make a complete change in appearance from juvenile to adult. These nine orders contain the majority of insect species. In fact, they number more than all of the other species in the entire animal kingdom! This major group includes beetles, moths and butterflies, flies, fleas and stinging insects (including ants, bees and wasps).

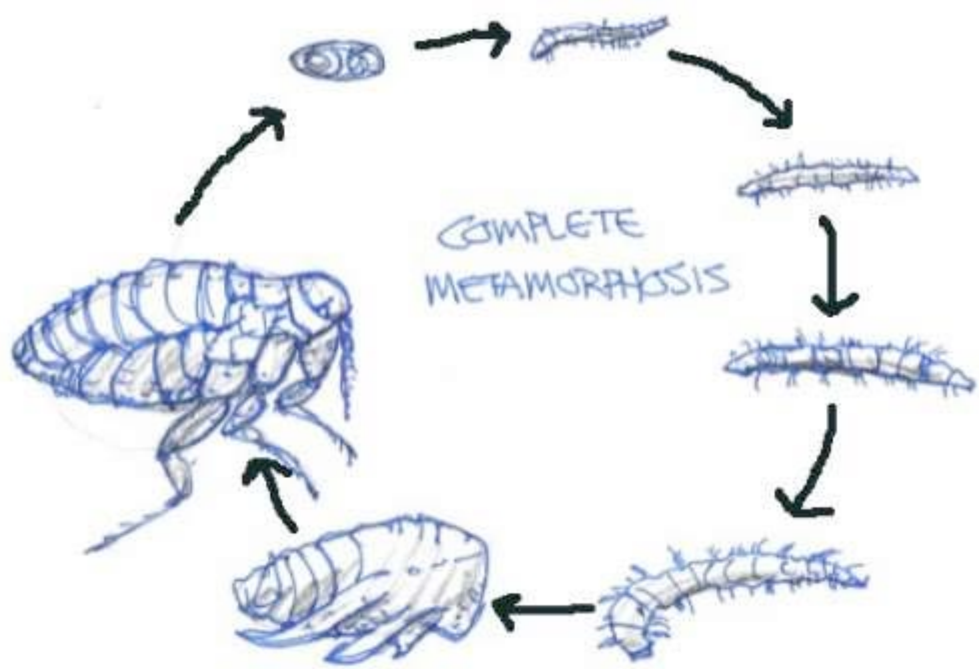


Figure 6. Development by complete metamorphosis using the example of a flea (Courtesy of Ben Gromicko)

Insects that develop by complete metamorphosis hatch from eggs as larvae (including grubs, maggots and caterpillars). The mission of the larval stage is to feed and grow. Larvae continue their development through a number of molts until they become mature; then, they change into pupae. The purpose of the inactive pupal stage is one of change or body rearrangement resulting in a complete change into the adult stage. Reproduction occurs during the adult stage.

The Biology of Termites

Termites live in true social colonies with a division of labor among the various types of individuals. These different types, called castes, usually consist of reproductives, soldiers and workers. Castes vary considerably among the various species.

Termites develop via gradual metamorphosis from eggs laid by reproductives. Nymphs hatch from the eggs and undergo several molts through which individuals develop into one of the various castes. Termites found in the United States are generally grouped into three categories: drywood, dampwood and subterranean.

Termite Distribution

Several species of subterranean termites are found in the United States; they live in every state except Alaska. The introduced Formosan subterranean (*Coptotermes formosanus*) is one of the most aggressive and economically important species of termites and has been found along the Gulf of Mexico and Atlantic coast.

This termite is found mainly in tropical regions but may be moved into more temperate areas through the shipment of infested wood. Other subterranean termites of economic importance in the United States include the light southeastern subterranean termite (*Reticulitermes hageni*), the southeastern subterranean termite (*Reticulitermes virginicus*), the Pacific Coast subterranean termite (*Reticulitermes hesperus*), and the arid land subterranean termite (*Reticulitermes tibialis*).

One of the most common types of subterranean termites found in the United States is the eastern subterranean termite (*Reticulitermes flavipes*). It is thought to be the most common and widely distributed termite in the entire North American continent.

CHAPTER 2: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

***Insecta* is distinguished from the other arthropod classes by the three body regions: head, thorax and _______.**

- (•) abdomen (correct)
- ( ) thorax
- ( ) anterior
- ( ) tail

The arthropod body is confined in its ______________.

- ( ) frame
- ( ) fitting
- (•) exoskeleton (correct)
- ( ) skelton
- ( ) chitin

- eposkeleton

Insects generally form a new, soft exoskeleton under the old one, then shed or _______ the old one.

- melt
- molt (correct)
- make

This group makes no drastic change in form from juvenile to adult.

- complete metamorphosis
- gradual metamorphosis
- simple metamorphosis (correct)

In the group that includes termites, cockroaches, crickets, grasshoppers, boxelder bugs and earwigs, individuals hatch from the egg only partially resembling the adults.

- complete metamorphosis
- gradual metamorphosis (correct)
- simple metamorphosis

Insects that develop by ____________ make a complete change in appearance from juvenile to adult.

- simple metamorphosis
- gradual metamorphosis
- complete metamorphosis (correct)

Termites live in true social colonies with a division of labor among the various types of individuals called ______.

- families
- cliques
- castes (correct)
- social groups

Termites found in the United States are generally grouped into three categories: drywood, dampwood and ___________.

- ○ underground
- ○ hardwood
- ○ swarming
- ◉ subterranean (correct)
- ○ wetwood

One of the most common types of subterranean termites found in the United States is the ______________________.

- ○ southeastern subterranean termite
- ○ Formosan termite
- ◉ eastern subterranean termite (correct)
- ○ North American coptotermes
- ○ western subterranean termite

CHAPTER 3: TERMITES

Termite control represents a major portion of pest control work. No other type of pest control involves as many variables that affect the work to be done or the results obtained. Technicians involved in termite control must have a thorough understanding of the biology and unique habits of the termites, including their food, and moisture and temperature requirements.

Technicians must also have knowledge of building construction, as well as the equipment, chemicals and safety precautions involved in termite control.

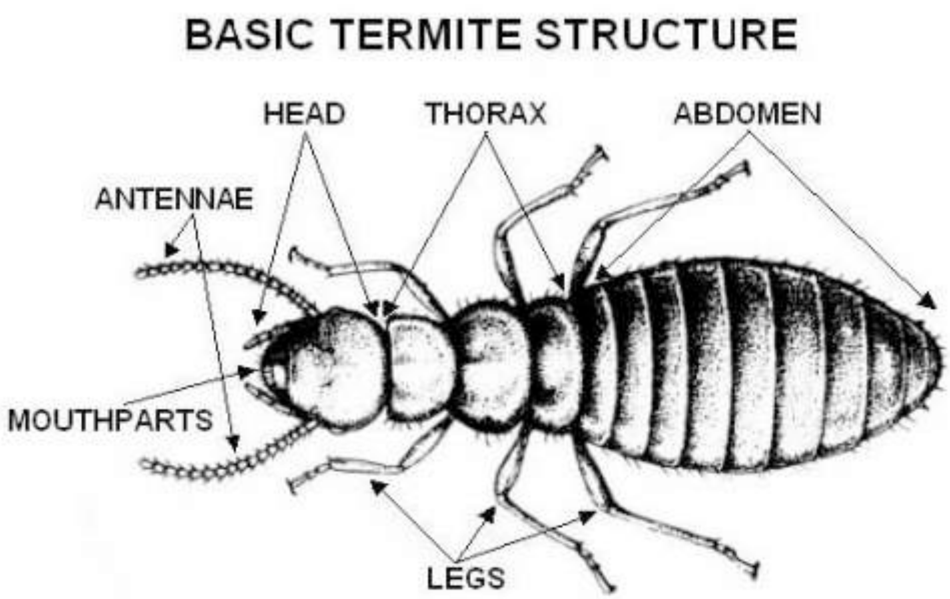


Figure 7. Basic termite structure

Termites are primitive insects belonging to an order of insects known as *Isoptera,* which means "equal wings." This refers to the fact that both pairs of wings on the winged forms (called alates or swarmers) are of equal size and shape.

Termites are thought by some to be closely related to cockroaches, but they are different from almost all other insects because they can convert the cellulose of wood into starches and sugar and use it for nutrition.

Figure 8. Alate or swarmer

Termites feed upon materials that contain cellulose, such as wood. Many species of termites cannot digest cellulose to extract the sugar content, so they rely on protozoa in their gut to do the job. They can do this because of a mutually beneficial association with the micro-organisms in their digestive tracts that convert cellulose into simple substances that termites can digest.

In nature, termites are very beneficial insects because they return dead trees to the soil as nutrients. Termites help convert dead wood and other materials containing cellulose into humus. Unfortunately, termites do not distinguish between wood in a structure and wood in a dead tree in the forest. Termites are considered to be pests when they attack structures built and inhabited by humans. Subterranean termites are one of the most potentially damaging insect pests of structures in the U.S.

Entomologists have described about 2,200 species of termites for the entire world; however, only 70 of these species infest structures and require control.
There are 13 species of termites in the continental United States that require man's attention to a greater or lesser extent.

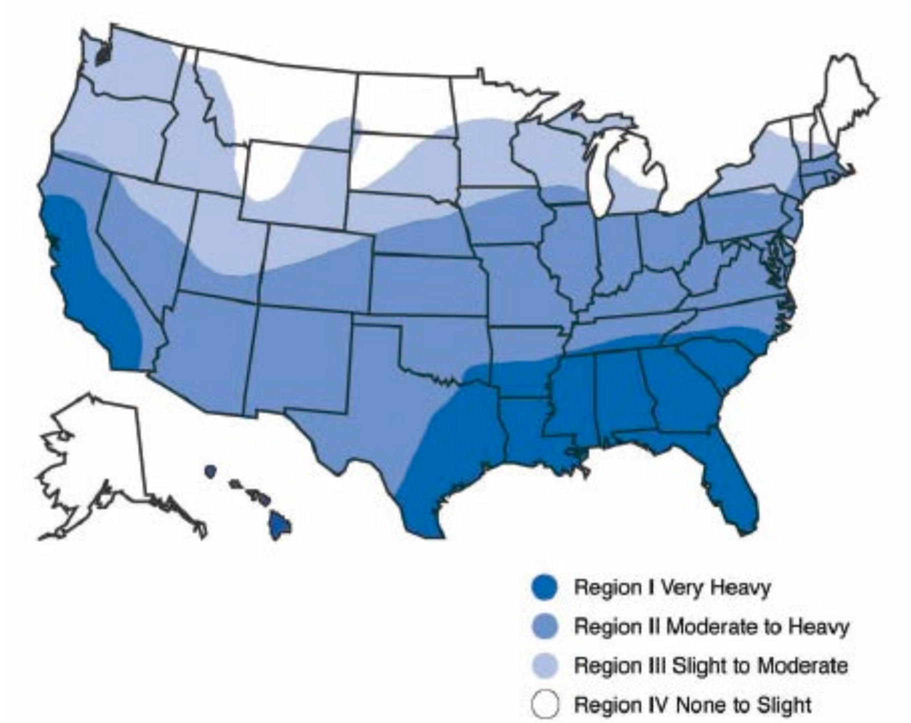


Figure 9. Termite activity in the U.S.

Termites occur in every state of the United States and parts of Canada. Subterranean termites are the most common type of termites found in the United States. To date, they have not been reported in Alaska. They cause varying degrees of trouble, depending on the geographical location. The presence and abundance of termites in an area is determined by several factors, including temperature, humidity, soil type and soil moisture. Because subterranean termites rely on soil moisture, they are affected by soil types. In clay soils, moisture is not as readily available because it is tightly bound to the soil particles. Sandy soils have more available moisture. Consequently, subterranean termites are generally more prevalent and more able to survive in sandy soils. Fungi in wood are another source of moisture.

Subterranean Termites

Subterranean termites are native, soil-inhabiting insects that feed on wood, paper and similar materials containing cellulose. They primarily nest underground. They excavate an extensive network of galleries or tunnels in the soil that allow them to travel far distances to locate food. Subterranean termites readily transport soil and water to above-ground sites. Soil provides an environment that satisfies the high moisture requirements of subterranean termites. In order for these soft-bodied insects to keep from drying out, they must be surrounded by relatively high humidity not only when they are in the soil, but also when they are foraging above ground.

The economic importance of subterranean termite attacks on buildings is related to the fact that wood members of a building closest to the soil, such as sills, joists, studs, girders and other important load-bearing elements of construction, are most likely to be severely damaged by termites. Failure to stop termite attacks can cause loss of support. Other forms of building deterioration, such as sagging walls, leaking surfaces and wood decay can follow. Heated buildings where wood is in direct contact with or in close proximity to the soil offer termites the ideal environment, a favorable year-round climate, and an abundant sheltered food source.

Subterranean termites are social insects that live in colonies. The social exchange of food (trophallaxis) and mutual grooming are important aspects of colony life. Termite colonies are comprised of various types of individuals (or castes) that have distinct physical and behavioral characteristics. The proportion of each caste is regulated by a variety of environmental factors, as well as the presence or absence of caste-regulating chemicals (pheromones) produced by the termites themselves.

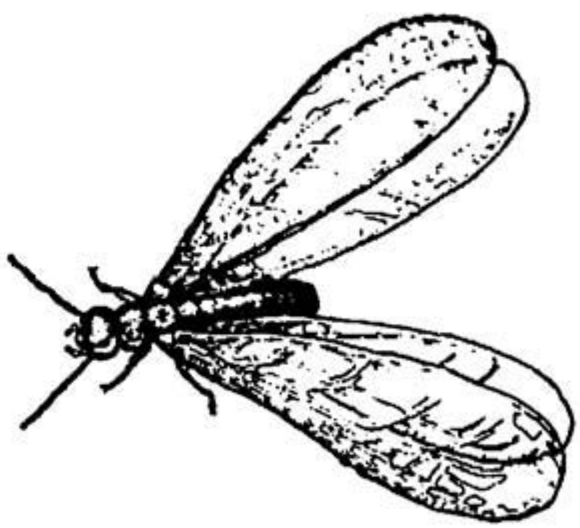


Figure 10. Swarmer termite

Figure 11. Swarmer termite

These castes include workers, soldiers and reproductives (queen, king neotenics). Each caste has different duties in the colony. The winged primary reproductive adult (swarmer, alate, flying termite) is the form most often seen. Adult winged termites have two pairs of long, narrow wings of equal size, thus describing the name of the order of classification to which termites belong: *Isoptera*, with *iso* meaning "equal," and *ptera* meaning "wing." The winged female and male reproductives are known as alates or swarmers. Alate termites have fully functional wings and eyes, and their pigmented, dark skin can better tolerate water loss than immature termites.

These reproductives or swarmer termites are about 3/8-inch long. The two pairs of gauzy or semi-transparent wings of identical size and shape extend beyond the body to twice its length. The antennae or feelers, like those of all termites, resemble a string of little globular beads.

In nature, termites start new colonies by the process of swarming. A swarm is a group of winged male and female reproductives (swarmers, alates) that leave the colony in an attempt to pair and initiate new colonies. Swarming occurs in mature colonies that typically contain at least several thousand termites.

Figure 12. Queen and king reproductive termites

Large numbers of winged individuals emerge on warm, sunny days (usually when temperatures are at least 64° F) after a rain as early as March or April, but usually in late April to early May. After taking flight and finding mates, the termites lose their wings, search out a place to start a nest, mate, and begin rearing the first group of workers. The mated female becomes the queen and the male the king.

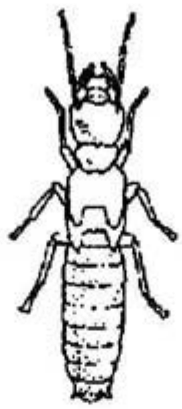


Figure 13. Secondary reproductive

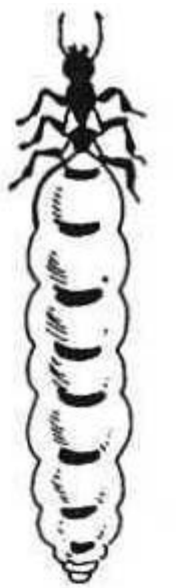


Figure 14. Mature termite queen

In very large colonies, a secondary reproductive caste may also be seen. These supplemental or secondary reproductives mate and reproduce within the existing colony. These termites are light-colored and typically have two pairs of short wing pads. Usually, they exist in addition to the regular mature queen but may become the most important source of eggs in the colony. They are formed as needed and can also take the place of the queen if she is injured or dies. Thus, strong colonies have multiple queens. These additional reproductives also give the colony a chance to spread through the process of "budding," where a number of workers or secondary reproductives can be cut off from the main colony and form a new, self-sufficient colony.

The worker caste makes up the bulk of the colony and is directly responsible for damage to wood. Workers are the first termites seen when a shelter tube or piece of wood is examined. Termite workers are physically and sexually immature males and females. These wingless, white insects are blind; they probably only perceive changes in light intensity.

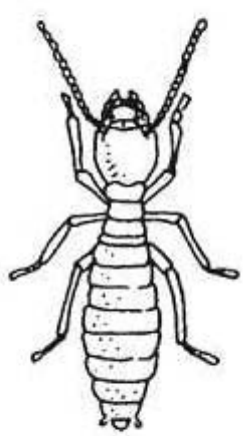


Figure 15. Worker termite

Figure 16. Worker termites

Figure 17. Worker termites

Workers are about 1/4-inch long, whitish-colored and soft-bodied. Recent studies of living colonies suggest that there may not be a true worker caste in common North American species. They may actually be late instar nymphs. Termite workers are sterile and dedicate their lives to the upkeep, feeding and sanitation work of the colony. Their need for moist, humid environments requires workers to live within the ground or in mud tubes that are constructed up into the wood they are attacking. Workers are rarely seen unless infested wood is examined or the mud tubes are broken open. Because of their thin skin, workers will dry up and die within three to six hours if exposed to the drying conditions outside the nests. The nymphs and adult workers both have thin, bead-like antennae and differ only in size.

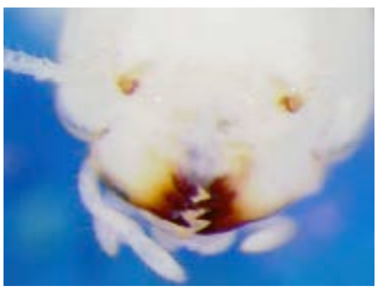
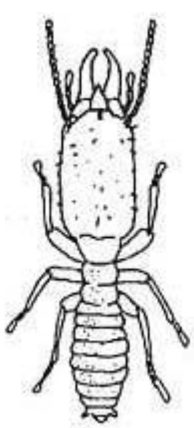


Figure 18. Termite mandibles

As workers eat wood, they cause damage to a structure. Their hardened mandibles have saw-like edges that enable them to rip and tear bits of wood. Workers are so named because they perform most of the labor associated with colony maintenance. Worker termites are involved in a variety of tasks: they forage for food and water; they excavate, repair and build galleries and shelter tubes; and they feed, groom and care for other colony members, particularly young termites, reproductives and soldiers. Workers also participate in colony defense.



Figures 19 and 20. Soldier termite

Soldier termites form another caste found in colonies. Termite soldiers are physically and sexually immature males and females. Their primary function is defense of the colony. Soldiers are easily recognizable by their large, rectangular, yellow-brown heads, and long, hard, black jaws or mandibles. The mandibles are used to rip and tear at invading insects, such as ants. Soldier termites are wingless, blind, and otherwise soft-bodied.

Their main responsibility is defending the colony from attack by ants and other termites. Termite soldiers cannot feed themselves. Workers provide them with regurgitated food.

The sterile soldiers are far less numerous than the workers. Soldiers typically comprise up to 2% of the termites present in a colony. They hide within the mud tubes and in the nest, and will not be seen unless the wood or mud tubes are disturbed.

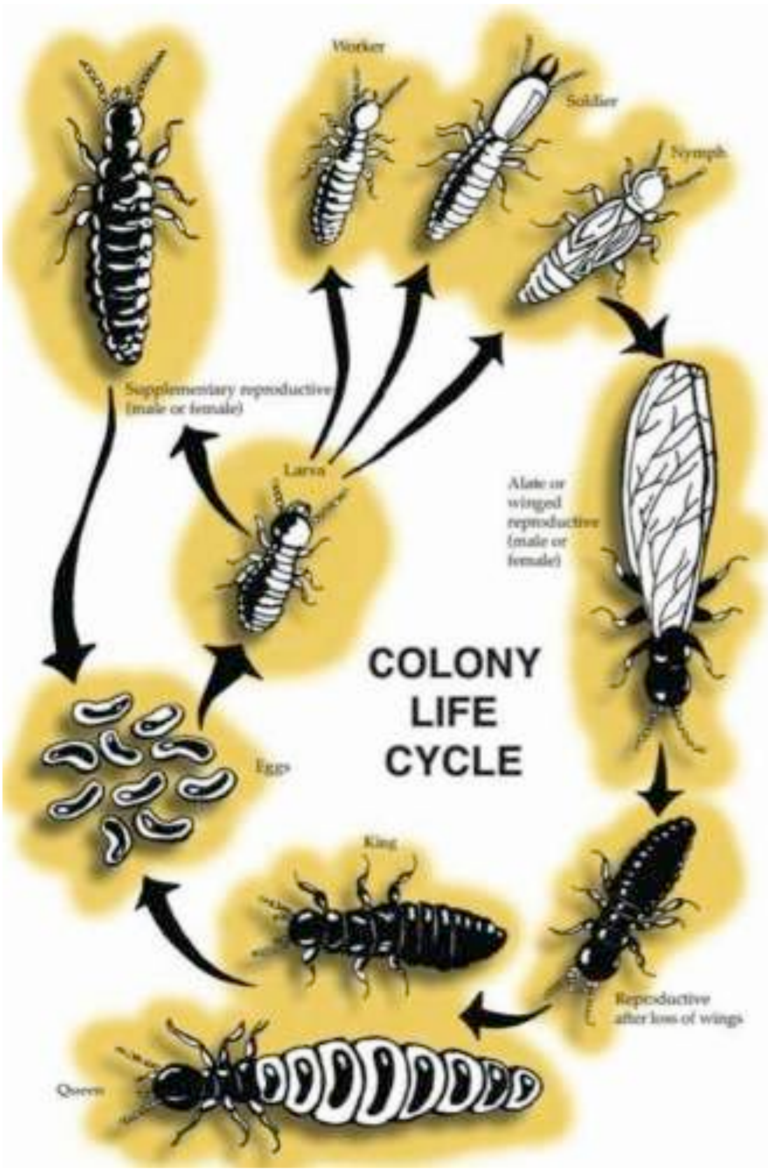


Figure 21. Termite colony life cycle

Many people confuse the winged primary reproductive termite with flying ants, which can also be found swarming near structures. Termites can be distinguished from ants by comparing their physical characteristics. It is very important that the inspector recognize the differences between termite swarmers and ant swarmers. Winged termites are often mistaken for winged (alate) ants because they have a somewhat similar appearance. However, these insects can be readily distinguished from each other by differences in their antennae, body shape and wings.

Winged termites (alates) have straight antennae, whereas ants have distinctly elbowed antennae.

Termites are soft-bodied and the abdomen is broadly joined to the thorax, whereas ants are hard-bodied and they appear to have a pinched "waist" at the junction of the thorax and abdomen. Termites and ants both have two pairs of wings, but termites have wings of equal length, whereas ants have larger front wings than hind wings. Winged ants do not readily shed their wings after flight, but termites do.

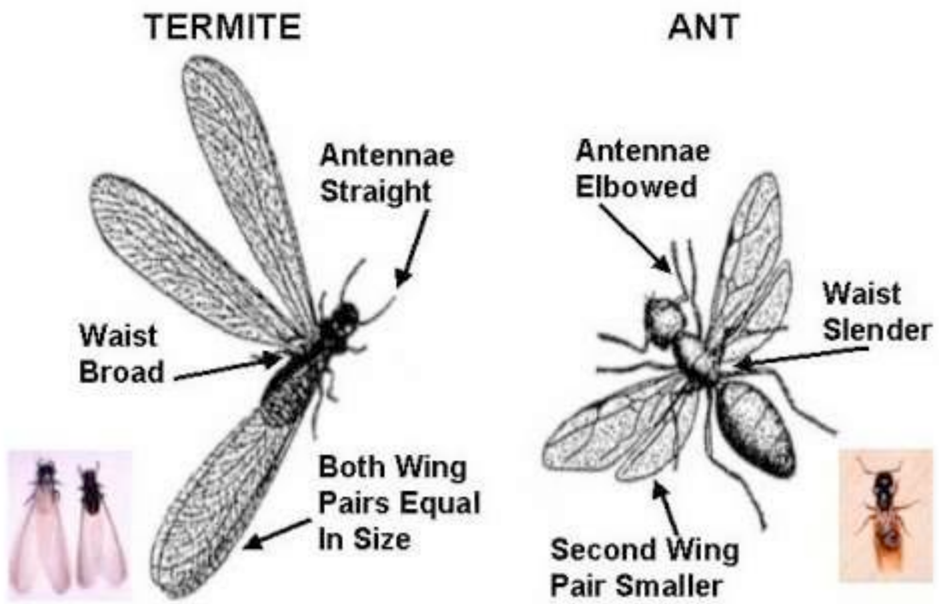


Figure 22. Termite vs. ant

Biology and Habits

General Facts

A colony, usually between two and six years old, becomes large enough to produce swarmers. At this time, the colony consists of thousands of individuals, both growing and mature. When swarming occurs, both winged males and females emerge from the colony, pair off and fly away to begin new colonies. They lose their wings and construct a small cell in or near wood where they mate. They are known as the primary reproductives. They are the colony founders, and the pair serves the reproductive role in the colony. They mate, reproduce and rear the first group of workers. The mated female becomes the "queen" and the male the "king."

Usually, the large numbers of swarmers never survive to establish colonies but are preyed upon by birds, toads and other animals, or they die from adverse environmental conditions. Indoors, their usual fate is to die harmlessly within a few days.

Swarming activity occurs during daylight hours over several days or weeks and usually follows a rain. Environmental conditions, such as heat, light and moisture, trigger emergence of swarmers. Swarms can occur indoors, particularly in heated structures during the winter or other times of the year. Each species has a definite set of conditions under which swarming occurs. This is why swarming varies according to the time of year and the region of the country.

Swarming and Mating
Most social insects swarm. This is one means by which certain social invertebrates perpetuate their species. A well-established colony of termites may develop hundreds to thousands of winged kings and queens (the primary reproductives), depending on the species. This usually occurs during the time of year best suited to the needs of the termite.

Subterranean termites prefer warmth, and there must be enough moisture present so that they will not desiccate. Therefore, on the first warm day following the first spring rains, subterranean termites frequently emerge from their swarm tubes in great numbers. Records show swarming has occurred in every month of the year in many states.

Figure 23. Swarm castle or swarm tubes

Termite swarmers often leave the colony in hundreds to thousands through specially constructed mud tubes, sometimes called swarm castles or swarm tubes. Swarming occurs during a brief period (typically, less than an hour), and alates typically shed their wings soon after flight.

The act of swarming is dangerous for termites. Winged termites tend to be weak fliers and are easy prey for hungry birds and predacious insects. Generally, less than 3% of the swarming termites survive. The wind has a strong influence on the direction and distance traveled by the new kings and queens. Once they have emerged from the nest, the primary reproductives eventually strike the ground out of exhaustion or by accident. The success rate of colony establishment via swarming is extremely low because most alates succumb to predation, desiccation and other environmental factors. Many homeowners first become aware of a structural infestation when termites swarm indoors.

Figure 24. Swarmers or alates

Winged termites are attracted to light, and evidence of their shed wings in cobwebs, in light fixtures, and on window sills and other surfaces often may be the only clues that a termite swarm occurred indoors.

The discarded wings are useful for identification purposes because the wing shape and venation (the vein pattern) are unique to termites. These shed wings are an important clue for the wood-destroying insect inspector.

After the swarmers land on the ground, random pairing commences at once. The queen seeks a suitable location to start another colony. While she is doing this, a king or several kings line up and follow behind her. Before mating takes place (or a first chamber is built), termites break off their wings along a basal suture (or a bottom joint).

Subterranean termite queens usually locate their original nests in the soil, frequently near buried wood. Drywood termites prefer a crack in almost any kind of wood to locate their nests. Once mating has occurred (from just hours to a week or more after swarming), the queen produces eggs of the desired caste.

The queen is capable of producing a very large number of eggs. The majority of the termite colony is comprised of immature individuals. The tiny termite that has just hatched from an egg is called a larva.

The termite larvae are unable to feed themselves and rely on workers to regurgitate food for them. Individuals that have wing pads are called nymphs. The nymphs' wing pads grow larger with each molt, and their compound eyes develop before their final molt into mature adults (alate, winged reproductive).

Subterranean termites develop through three growth stages: egg, nymph and adult.
The terms larva and nymph are unique to termites; such terminology is not necessarily representative of other insects that also undergo incomplete metamorphosis.
A fertilized female or queen produces eggs. The young termites hatching from the eggs are called nymphs and are white or pale cream-colored, soft-bodied and blind. They have three pairs of legs and, though capable of moving about, must first be cared for by other termites. Later, the nymphs can feed on wood and take care of themselves.

In a colony, some nymphs develop large heads with a hard, brown skin and large jaws or mandibles. These individuals are soldier termites. Other nymphs develop two pairs of wing pads on their backs, and at the final molt to adulthood, emerge as dark-colored, winged reproductives with fully developed eyes. In very large colonies, some of the developing potential reproductives become reproductively mature males and females but with arrested wing development. These supplemental reproductives may mate within the colony and never leave it. Reproductive needs of such colonies are often taken over entirely by supplemental
reproductives.

Some males and females can mature sexually and become neotenic reproductives. These neotenics serve as replacement reproductives if the king or queen dies. Neotenic reproductives are generally yellowish brown or a mottled black, and the female's abdomen may be distended due to developed eggs. Numerous male and female neotenics can live in a colony. Their contributions to egg production can greatly enhance a colony's growth.

Colony History
During the spring or summer months, a mated pair of winged termites establishes a new colony, beginning with the young hatching from the small number of eggs first produced by the female.

These nymphs become workers, and more young are produced, and thus the colony grows. However, a “budding-off” process in which a number of workers and some supplemental reproductives become physically isolated from the original colony can also produce new colonies. Human activities, such as digging a cellar, laying a foundation, or even applying soil insecticides, can bring this about. Thus, when a building becomes infested with termites, there may be no sure way to tell whether the infestation began as a completely new colony or is an isolated fragment of another colony, or whether a colony located in a nearby fence post, for example, simply moved in to take advantage of the year-round warmth of the building.

Critical Needs

Subterranean termite specialization requires that they live almost constantly in an environment of high relative humidity. Because of this, they need access to the earth. Because of soil moisture, the air spaces between soil particles are almost always very humid, and this humid atmosphere is important to the termite colony. Cutting off this ground contact with soil moisture is, therefore, the main principle in termite control. Other sources of moisture, such as roof or gutter leaks, defective plumbing, etc., also serve the termites' needs but only if sustained over long periods.

Maintaining humidity in the feeding cavities is a problem for the termite. Masonry and wood absorb moisture. To reduce such losses, termites line their tunnels with salivary secretions that harden to form a moisture-impervious layer. Although masonry and wood absorb moisture, termites are often unable to feed in wall studs at distances of more than a few feet from the floor because they are too far from their humidity source. Floor joists also represent an increasing linear distance from the moisture source. To provide more moisture to the joists, termites often construct earthen-lined shelter tubes upward to and downward from the joist. Subterranean termites construct tube-like structures from the soil to the wood they are infesting. These structures are called shelter tubes or mud tubes. The tubes are formed from a mixture of soil, wood particles, fecal material and a saliva-like substance. They are simply an extension of the nest above ground serving as protection and a means to regulate moisture.

Figure 25. Termite mud tube (Courtesy of Ben Gromicko)

Figure 26. Termite mud tube (Courtesy of Ben Gromicko)

Figure 27. Termite mud tube (Courtesy of Ben Gromicko)

Termite shelter tubes are one of the best clues for the wood-destroying insect inspector. Termites may often go undetected if not for the presence of a mud tube on a foundation wall or a wooden beam. Alternatively, it is possible that the inspector may find evidence of termites in a structure, yet find no evidence of mud tubes.

Poorly ventilated crawlspaces typically provide an atmosphere of high relative humidity that permits the joists to absorb moisture and thus facilitate termite damage.

A second critical need of subterranean termites is a constant source of wood or cellulose-containing material from which they derive their nutrition. Paper, cotton, burlap and other plant products are often actively attacked and consumed by subterranean termites.

Unlike the carpenter ant, termites cannot hibernate and must continue to feed and be active throughout the winter. Severe winter cold prevents termites in the woodland from feeding in stumps above ground during much of the season. However, wood in close contact with heated soil, which is common in house design since the 1920s, provides a favorable habitat during winter.

Wood is made up of three dominant ingredients: cellulose, lignocellulose and lignin. All plants have varying amounts or proportions of each of these organic substances. The more cellulose there is in a plant or plant product, the more attractive it is to a termite.

Some woods have chemical substances that confer variable susceptibility to termite attack. There are also woods that are somewhat immune to termite attack, especially their heartwood, such as cypress, redwood and cedar. Wood products, such as paper, are favorite foods since they are nearly pure wood pulp and cotton fiber. The lignin, a substance avoided by these pests, is removed during the paper-manufacturing process.

Although subterranean termites usually locate their nests in the soil, there are situations in which termites can survive without soil contact if their requirements for food and water are met. Termites have been known to maintain an active, viable colony solely in the structure without soil contact if an above-ground moisture source is available. This situation may occur from a plumbing or roof leak that goes undetected.

Subterranean termites cannot digest cellulose themselves, and are among the species dependent on large numbers of one-celled micro-organisms (protozoa) that exist in the termite gut. These protozoa break down the cellulose, a complex sugar, to simpler compounds that termites can further digest as food. Worker termites and older nymphs consume wood and share their nourishment with the developing young, other workers, soldiers and reproductives.

Certain types of fungi play an important role in a termite’s life. Termites are highly attracted to odors produced by wood-decaying fungi that, through the decaying process, make the wood easier to penetrate. In some instances, the fungus provides a source of nitrogen in the termite's diet.

Termite colonies are remarkably non-combative. It is entirely possible for ants and termites to infest the same building, each producing its winged adults at the appropriate time. There is interaction only if the ant colony finds it expedient to feed upon individuals of the termite colony.

Signs of Infestation

Generally, the first readily noticeable sign of infestation is the presence of swarming reproductives on window sills or near interior lights. If swarmers are found indoors, it is usually an indication that an active infestation exists somewhere within the structure.

The presence of swarmers outdoors is a naturally occurring phenomenon but should be a warning that termites are in the vicinity and are possibly attacking a nearby building.

Another indication of infestation is the presence of wings that were discarded by the swarmers as a normal part of their behavior, which are typically found near emergence sites, on window sills, in cobwebs, and inside in-floor heating and air ducts.

Also, any sub-slab ductwork for venting a heating unit or cooktop range ventilator can develop cracks that allow termites to enter below grade. If any of these conditions exist, they should be carefully inspected and, if possible, corrected.

Figure 28. Termite damage

Damaged wood often is not noticed unless the exterior surface is removed. However, galleries can be detected by tapping the wood every few inches with a screwdriver. A sharp, pointed tool is a useful probe that can penetrate through the outer layer of wood to reveal termite damage. Damaged wood will sound hollow and the screwdriver may even break through into the galleries. Subterranean termite feeding follows the grain of the wood and usually only the soft springwood is eaten, leaving the harder summerwood. The galleries will contain soil that has been moved by the termites. The gallery walls are often spotted with termite excrement and fecal particles.

Figure 29. Termite damage

Subterranean termites do not push wood particles or pellets (fecal material) outside the galleries, as do other wood-boring insects, but rather use them in the construction of their tunnels. Any penetrations through the wood surfaces are covered with earthen construction material produced by the termites. Termites are unable to hear noises near their nests but they are immediately alerted when their nest is tapped because they can detect vibrations through their legs. When alarmed, the soldier termites butt their heads against the gallery walls to initiate the vibrations that will warn the colony. Under certain circumstances, it is possible to hear this “ticking” sound.

Figure 30. Termite shelter tube

Another sign of infestation is the presence of flattened, earthen shelter tubes that the termites build over the surface of the foundation in order to reach the wood of a structure.

Figure 31. Suspended or drop tubes

These tubes are usually 1/4- to 1/2-inch wide. Termites perish rapidly under dry conditions, so they build these mud tubes to maintain adequate humidity throughout the colony. Buildings should be inspected at least once a year for evidence of tubes. In concrete-slab construction, inspectors should closely examine the expansion joints and cracks where pipes and ducts go through the slab, paying particular attention to bath plumbing traps and exposed soil beneath the heating and air conditioning systems.


Figure 32. Termite tube on sill plate (Courtesy of Ben Gromicko)

When looking for signs of termite activity, the inspector must also be alert to those conditions that favor termite infestation. The most critical condition is wood-to-soil contact.

Figure 33. Termite tube on sill plate (Courtesy of Ben Gromicko)

The Pick Test

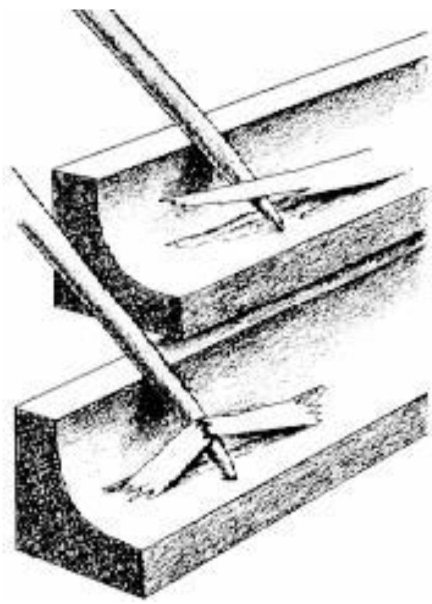


Figure 34. Pick test

Both homeowners and home inspectors can investigate a home or building using the pick test. Use an ice pick or screwdriver to probe wood you think might be decayed based on its color or other changes you detect. Insert the pick about 1/4-inch into the wood and press sharply downward, perpendicular to the grain. If the wood is sound, a long splinter will pull out of the wood along the grain. If the wood is decayed, the splinter will be brittle and break into short pieces across the grain, especially at the point where the pick enters the wood and acts as a lever. You can also detect decayed wood by its lack of resistance relative to sound wood. Mudsills (wood installed on footings) can be pick-tested without producing excessive visual or structural damage, since they are not visible from outside the crawlspace. Sometimes, wood treated with a preservative on the surface is decayed inside. The pick test can help reveal these hidden pockets of decay.

The U.S. Forest Service has identified 15 conditions that frequently lead to termite infestation:

1. Cracks in concrete foundations and open voids in concrete foundations are hidden avenues of entry.

2. Any wooden posts or supports set in concrete may be in contact with the soil underneath.

3. Concrete porches with earth fill may provide wood-to-soil contact.

4. Form boards left in place contribute to the termite food supply.

5. Leaking pipes and dripping faucets in the crawlspace keep the soil under the structure moist.

6. Blocking crawlspace vents with shrubbery will cause the air under the structure to remain damp and warm.

7. Construction debris in the backfill beside the structure will contribute to the termites' food supply.

8. Low foundation walls and footings will provide wood-to-soil contact.

9. Stucco or brick veneer carried down over the concrete foundation allows for hidden access to the structure.

10. Soil-filled planters built up against the side of a structure allow direct access into foundation cracks.

11. Forms left in slabs where plumbing drains enter the structure provide access.

12. Wooden porch steps in contact with the soil are potential entry points.

13. Heating units in crawlspaces maintain warm soil temperatures for termite colonies year-round.

14. Paper is a wood product. Paper collars around pipes and ducts also provide access to the structure.

15. Wooden fences, trellises and other wooden adornments up against the side of a structure may provide access.

Estimates of damage caused by subterranean termites have been calculated by Dr. Mike Haverty (1976) of the USDA Southern Forest Experiment Station in Gulfport, Mississippi, and are indicated below:

Estimates of wood consumption are by a theoretical colony of eastern subterranean termites:

1. wood consumption rate (mg wood per gram of termite per day) = 33.2;

2. weight of worker (mg) = 2.5;

3. wood consumption per termite per day (mg) = 0.083;

4. estimated number of workers per colony = 60,000;

5. wood consumption per colony per day (gm) = 4.98;

6. days to consume 1-foot board of pine (where pine weighs an average of 0.5 gm/cc with 2359.7 cc/board foot or 1179.9 gm/board foot) = 236 days.

In other words, an average, mature colony of eastern subterranean termites contains about 60,000 workers. Under ideal conditions, such a colony would consume about 5 grams of wood each day. This is less than 1/5 of an ounce of wood. At this rate, it would take the colony about 157 days to totally consume a 1-foot length of a pine (2x4).

Drywood Termites

Drywood termites are very common in some southern and western states. They are easily transported to other locations in infested wood, such as within furniture and decorative items.

Drywood termites live and feed in dry, sound wood and can cause structural damage. They do not require contact with the soil and, therefore, they do not construct mud tubes. They consume wood with and across the grain, creating irregular, clean galleries.

Usually, significant damage requires a longer period to occur, as compared to subterranean termites, since drywood termite colonies develop at a slower rate. Also, since these termites live and feed inside sound wood, signs of external damage may go undetected for years.

Infestations may be found in structural timber and woodwork in buildings, furniture, telephone poles, lumber stacked in lumber yards, paper, cloth, fiber insulation boards, and in other products containing cellulose.

Identification

Drywood and subterranean termites are similar in general shape and conformation but differ slightly in size and coloration. They are found in colonies consisting of three castes: reproductives, workers and soldiers. Drywood winged reproductives (primary reproductives, swarmers or alates) generally are larger than subterranean termites, with dark brown, smoky gray or almost clear wings. The body color may vary from dark brown to light yellowish-tan. The drywood termite worker and soldier castes closely resemble those of subterranean termites. In most drywood termite species, there is no true worker caste, as this function is taken over by nymphs.

Biology and Habits

Nymphs hatch from the eggs within several weeks and are cared for by the new king and queen. After two molts, nymphs assume the role of workers and begin to feed and care for the original pair. Eggs are not deposited continuously; in fact, very few are deposited during the first year. In subsequent years, the young queen matures and begins to lay more eggs.

Eventually, the colony stabilizes when the queen reaches maximum egg production. At that point, the colony contains eggs, nymphs, workers, soldiers and reproductives. If the queen dies, secondary reproductives take over the queen's duties. The maximum size of a colony depends on several factors, such as location, food availability, and environmental conditions. Some colonies remain small, but adjacent, multiple colonies may contain up to 10,000 individuals. The colony grows through the queen's increased egg production and the accumulation of long-lived individuals.

Colony History

After a drywood termite colony has matured, which usually takes several years, swarmers are produced. The swarming activity occurs at dusk or during the evening, and the swarmers fly toward areas of greatest light intensity, gathering around lights and illuminated windows. Emergence is not often associated with a definite season of the year; most drywood termites emerge during the summer. Certain environmental conditions, such as heat, light and moisture, trigger the emergence of swarmers, and each species has a definite set of conditions under which swarming occurs. The number of swarmers is in proportion to the age and size of the colony, while environmental conditions regulate the numbers coming forth from the colony.

Critical Needs

Drywood termites derive their nutrition from wood and other materials containing cellulose. In fact, the greater the cellulose content is of a plant or plant product, the more attractive it is to drywood termites. Drywood termites often actively consume paper, cotton, burlap and other plant products. These termites are dependent on large numbers of one-celled micro-organisms (protozoa) that exist in the termite gut for cellulose digestion. The protozoa serve to break down wood particles to simpler compounds that termites can absorb as food.
Functional older nymphs consume wood and share their nourishment with the developing young, soldiers and reproductives.

Moisture is not as important to drywood termites as it is to the survival of subterranean termites. They require no contact with the soil or with any source of moisture. Drywood termites extract water from the wood on which they feed and from water formed internally by digestive processes. They require as little as 2½% moisture, but prefer wood with 10% moisture content.

Signs of Infestation

Generally, the first sign of drywood termite infestation is the presence of swarming reproductives found on window sills or near light fixtures. Swarmers found indoors are usually a clear indication of an active infestation somewhere within the structure if the doors and windows have been closed. Another indication is the presence of discarded wings found near the emergence sites, on window sills and in cobwebs.

Probably the best evidence of a drywood termite infestation is the presence of fecal pellets. Drywood termites construct “kick holes” in infested wood through which the pellets are eliminated from galleries and tunnels. These pellets accumulate in small piles below the kick holes or are scattered if the distance between the kick hole and the surface below is too great. Fecal pellets also may be found caught in spiderwebs.

Fecal pellets are distinctive and are used for identification. Drywood fecal pellets are hard, elongated and less than 1/25-inch long, with rounded ends and six flattened or concaved depressed sides with ridges at angles between the six surfaces. The characteristic shape results when the termite exerts pressure on the fecal material in the hindgut to extract and conserve moisture.

The interior of drywood termite-damaged wood contains chamber-like structures connected by galleries or tunnels that cut across the wood grain, including both soft springwood and harder summer-growth wood. Galleries have almost sandpaper-smooth surfaces containing few or no fecal pellets.

Dampwood Termites

Dampwood termites make up a distinct habitat group. Dampwood termites locate their colonies in damp, often decaying wood; but, once established, they can extend their activities into sound and even relatively dry wood. They enter wood directly at the time of swarming and always confine their work to wood. They are occasionally responsible for serious damage to wooden structures, usually in conjunction with fungus attack, since the moisture requirements of both are similar.

Flights (swarming) of the dampwood termites usually occur at dusk. Some flights occur throughout the entire year; however, peak annual swarming takes place in late summer and fall.

The winged reproductives of dampwood termites may be an inch or more long, including the wings; the wings are from 7/8-inch to 1 inch long. The body is light cinnamon-brown; the wings are light to dark brown, heavily veined, and leathery in appearance. The soldiers are 3/8- to 3/4-inch long, depending on the instar in which they assumed their typical soldier characteristics. This varies with the age of the colony, which is somewhat true of many species of termites. As with other members of this family, there is no worker class. The nymphs are about 1/2-inch long.

Formosan Termites

As with dampwood and drywood termites, a brief discussion is provided here for reference. This is an important species that is classified as a subterranean termite. Its habits are similar to our native species. The most obvious characteristics that distinguish the Formosan termite from native subterranean termites are their larger size, pale yellow body color, oval shape of the head of the soldier (compared to the oblong head of native subterranean species) and hairy wings. The Formosan termite also establishes larger colonies, is more aggressive, and can do damage much more rapidly. Formosan termites make nests of hardened, paper-like materials in wood in or on the ground, in hollows they have excavated from the tree stumps, or in hollow spaces in walls, floors or attics of buildings. Like the native subterranean termites, the Formosan termite builds earthen shelter tubes over objects that it cannot penetrate, such as concrete foundations.

There are reports of established infestations of Formosan termites in several regions of Louisiana and Texas. However, this species is occasionally transported in wood to other areas of the country; thus, it is gradually moving inland from these areas.

Monitoring Techniques for Formosan Termites

Detection of subterranean Formosan termites (*Coptotermes formosanus*) requires considerable experience, and various techniques may not be equally effective in all areas where the termite has been found. There are monitoring traps located in south Florida and Hawaii where aerial infestations of the Formosan subterranean termite in multi-level buildings are prevalent. Light traps are another tool for area-wide monitoring programs, but the cost of a light trap can be expensive. An alternative, developed in South Carolina, uses sticky traps attached to street lamp poles. Studies show that the greatest number of termites was caught 19 feet from the ground. Light traps should be used in the spring during the swarming season. Note that the month or time of year when Formosan termites swarm varies with the area.

Summary

The class *Insecta* belongs to the phylum *Arthropoda,* which includes other non-insect classes (spiders, mites, centipedes, crabs, etc). Insects are distinguished from other arthropods in that they do not keep the same appearance as they grow. Instead, they undergo a metamorphosis or a change in body shape as they develop from one stage to another.

Termites belong to the insect order *Isoptera* and undergo gradual metamorphosis. There are several termite species in the United States, but only the eastern subterranean termite (*Reticulitermes flavipes*) is a significant termite pest in Michigan. Four castes develop among termites, with each caste having a specific role in the establishment, defense, reproduction and maintenance of the colony. It is important that the pest management professional understand termite biology, behavior patterns, and environmental requirements so that the appropriate pest-control technique can be applied.

Other wood-destroying pests of economic importance include powderpost beetles, longhorned beetles, carpenter ants, carpenter bees, and decay fungi. The pest-management professional must become familiar with the damage caused by these pests to properly identify them and treat the infestation.

CHAPTER 3: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

T/F: Both pairs of wings on the winged forms of termites (called alates or swarmers) are of equal size and shape.

- (•) True (correct)
- ( ) False

T/F: Termites feed upon materials that contain cellulose, such as wood.

- ( ) False
- (•) True (correct)

T/F: In nature, termites are very beneficial insects because they return dead trees to the soil as nutrients.

- (•) True (correct)
- ( ) False

The social exchange of food (____________) and mutual grooming are important aspects of colony life.

- ( ) troposhere
- ( ) traxolusos

- phoxallaxis
- prottoclasix
- trophallaxis (correct)

A _________ is a group of winged male and female reproductives (swarmers, alates) that leave the colony in an attempt to pair and initiate new colonies.

- pairing
- group
- caste
- swarm (correct)
- flock

After taking flight and finding a mate, the termites lose their ________, search out a place to start a nest, mate and begin rearing the first group of workers.

- vision
- sense of direction
- wings (correct)
- mandibles

Masonry and wood that harbor termites absorb moisture. To maintain the proper level of moisture required for survival, termites line their tunnels with ___________ that harden(s) to form a moisture-impervious layer.

- salivary secretions (correct)
- moss
- larvae
- fungus

T/F: When discussing WDO, the term "nymph" is unique to termites.

- (selected) True (correct)
- False

When a shelter tube or piece of wood is examined, the first termites seen are the immature __________.

- queens
- (selected) workers (correct)
- soldiers
- alates
- kings

Galleries can be detected by __________ the wood every few inches with a screwdriver.

- (selected) tapping (correct)
- smelling
- drilling into
- charring

T/F: Unlike other wood-boring insects, subterranean termites do not push wood particles or their fecal material (pellets) outside their galleries, but instead use them in the construction of tunnels.

- (selected) True (correct)
- False

T/F: Because of the climate, drywood termites are common in certain southern and western states.

- (selected) True (correct)
- False

Probably the best evidence of a drywood termite infestation is the presence of ____________.

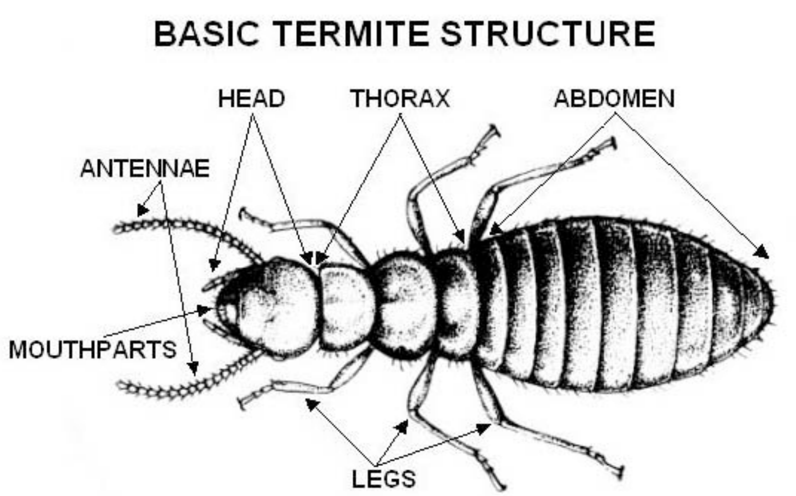
- shed wings
- damage

- holes
- fecal pellets (correct)

T/F: Dampwood termites locate their colonies in damp and often decaying wood, but once established, they can extend their activities into sound and even relatively dry wood.

- True (correct)
- False

CHAPTER 4: SUBTERRANEAN TERMITE TREATMENT



After succesfully completing this chapter, you should:

- know the basic types of building foundations;
- understand the techniques used to treat soil for the control of subterranean termites;
- understand how cracks and voids in foundations are treated to control subterranean termites;
- know the various types of pre- and post-construction methods used for controlling termites;
- know the techniques used to treat subterranean termite infestations for various types of building construction;
- understand how termite entry points vary, depending on factors such as foundation type, walls and flooring; and

- know how to calculate linear feet and square feet and to interpret a termiticide label so that the right amount of termiticide will be applied in both vertical and horizontal treatments.

This chapter discusses termite control procedures used for various types of building construction. It is important to remember that foundations can be of three general types: slab, basement and crawlspace. Each of these types of construction has structural features that require specialized attention to establish a physical or chemical barrier that prevents termite entry into the building.

For example, treatment outside the structure may involve trenching and treating or rodding to treat the soil on the outside of the foundation, rodding beneath slabs, or vertical drilling and treating of outside slabs, stoops or porches. Treatments inside may involve trenching and treating the soil along the foundation walls in crawlspaces, vertical drilling and treating slab foundations, rodding around bath traps and other utility openings, or treating wood directly. The examples that follow will outline the procedures to use in controlling subterranean termites for these and other elements of construction.

Foundation Types

There are three basic foundation types that pest-management professionals may encounter in termite control operations: slab-on-ground, crawlspace (including plenum crawlspace), and basement. Treatment procedures for each foundation type differ somewhat.

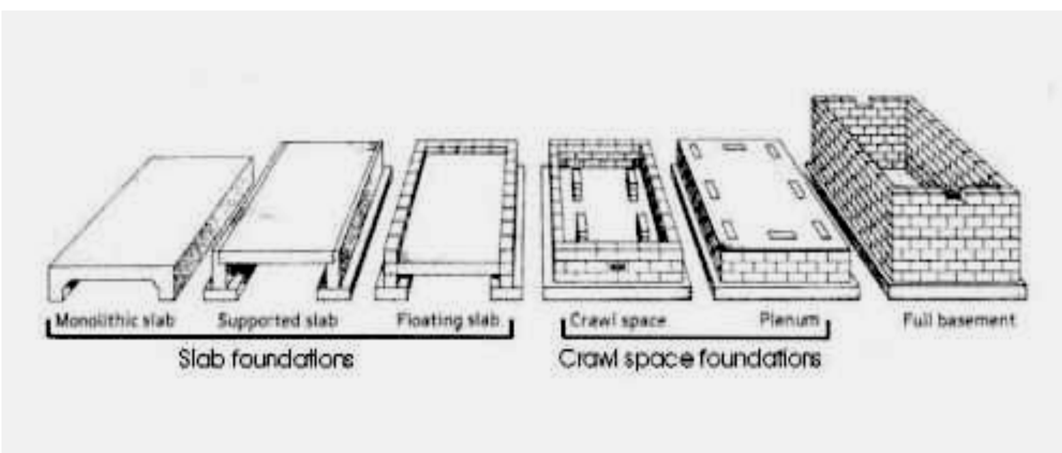


Figure 35. Foundation types (Mallis, Handbook of Pest Control, 7th Edition)

Slab-on-ground construction consists of three types: floating, monolithic and suspended slab. Termite entry points vary in each slab type; thus, different treatment procedures are required. Plenum crawlspace construction will be encountered more rarely.

Finally, basement construction is common in many states and requires special consideration, especially where there is a French drain or a sump pump.

Slab-on-Ground

This type of construction is used extensively. Because of the potential hazard of accidentally drilling through heat pipes or ducts, electrical conduits, and plumbing embedded in the floor, it may be advisable to treat from the outside by drilling through the foundation wall. Mechanical alteration is not usually necessary with this type of construction.

The three basic types of slab-on-ground construction are floating slab, monolithic slab, and suspended slab.

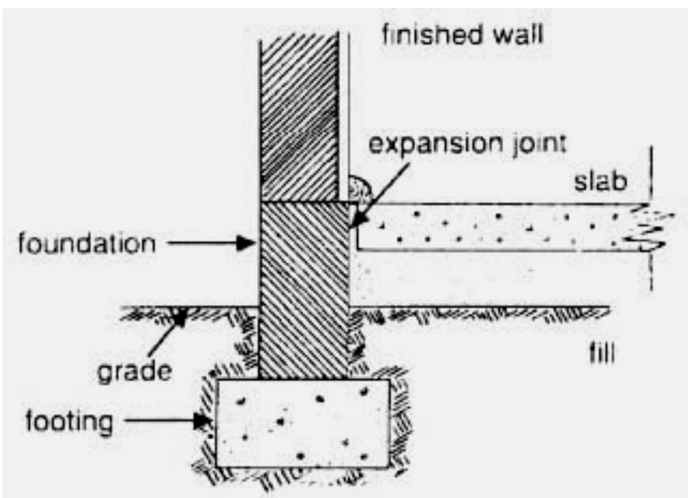


Figure 36. Floating slab construction

In floating slab construction, the foundation wall and footing are separated from the slab floor by an expansion joint. The slab floor is concrete; the foundation wall may be constructed of a variety of materials, such as solid block, hollow block, or concrete.

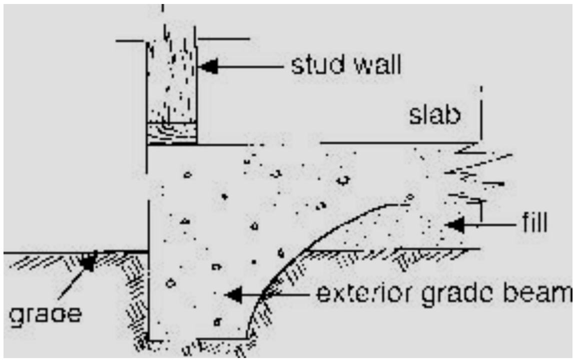


Figure 37. Monolithic slab construction

In monolithic slab construction, the foundation footing and the slab floor are formed as one continuous unit. Concrete is the material used in this type of slab foundation.

In suspended slab construction, the slab floor and the foundation wall are separate units, with the slab floor extending over the top of the foundation wall. The slab floor is concrete; the material used for the foundation wall may vary.

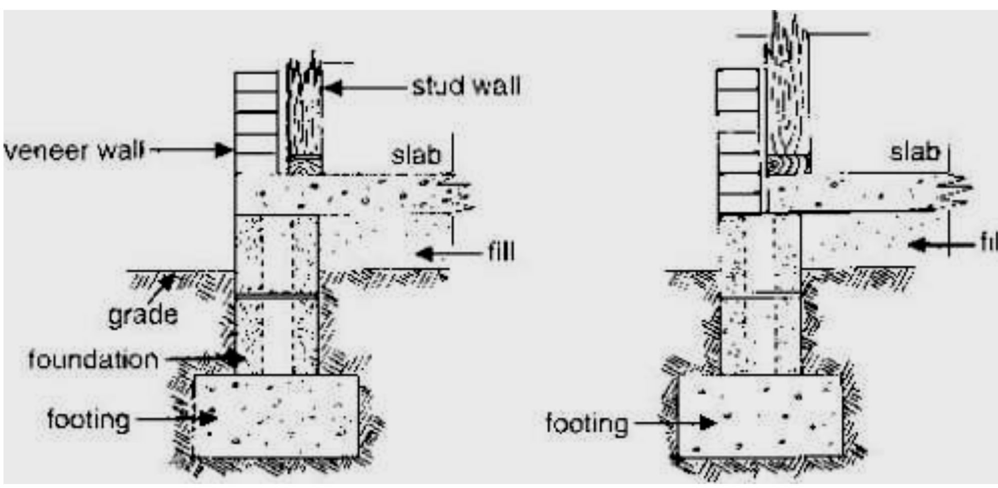


Figure 38. Suspended slab construction

Crawlspace Construction

A crawlspace is a shallow space below the living quarters of at least a partially basement-less house. It is normally enclosed by the foundation wall.

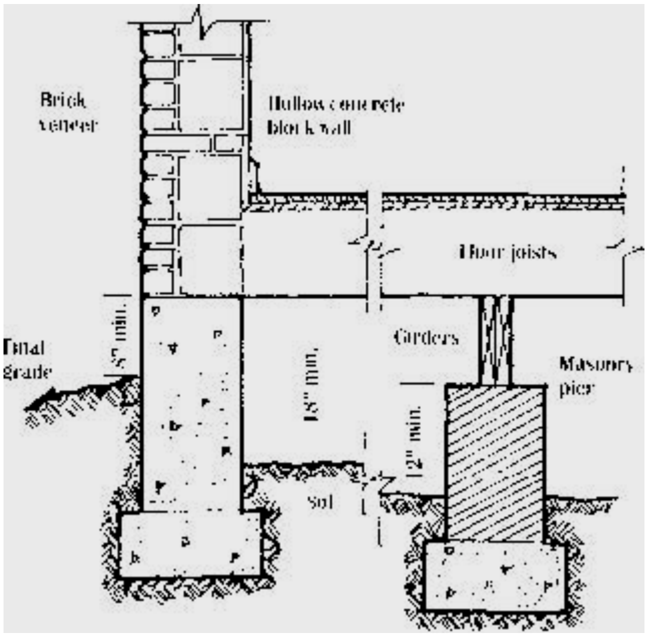


Figure 39. Crawlspace construction

Crawlspaces are usually less than 3 feet high with exposed soil underneath. This type of construction is common in many parts of the country. The exposed soil and the short distance to floor joists and sills make crawlspaces an ideal place for termites to find and infest wood.

Basement Construction

Though buildings with basements are less susceptible to termite attacks than slab-on-ground construction, basements do have their unique areas that are vulnerable to termite entry.

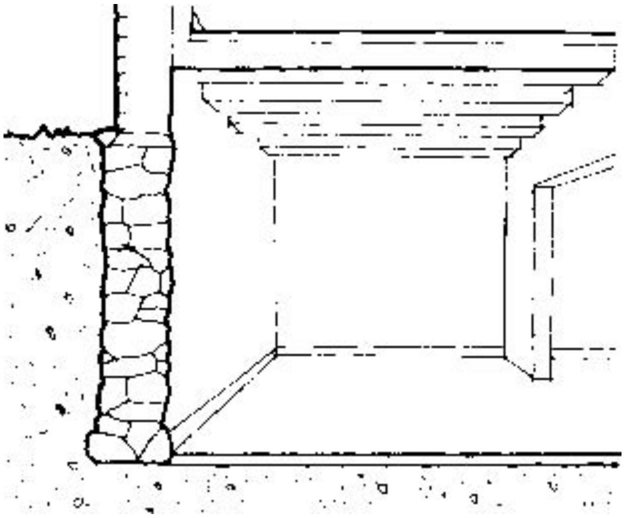


Figure 40. Basement construction

It is important to remember that termites can enter through a crack or crevice as small as 1/32-inch.

Soil and Foundation Treating

Soil treating consists of applying termiticides to the soil under and adjacent to a building to create an impervious chemical barrier. A continuous barrier should be established along the inside and outside of the foundation, under slabs, and around utility entrances.

Traditionally, soil is treated with chemicals to establish a barrier that is lethal or at least repellent to termites. The chemical must be adequately dispersed in the soil to provide a barrier to all routes of termite entry. A thorough and uniform barrier also prevents the termites that are feeding in the structure from returning to the soil for moisture. This causes their death by either dehydration or contact with residual termiticide.

Effective soil treatment depends on dispensing a sufficient amount of chemical to establish a barrier wherever there are termite entry points in each type of construction.

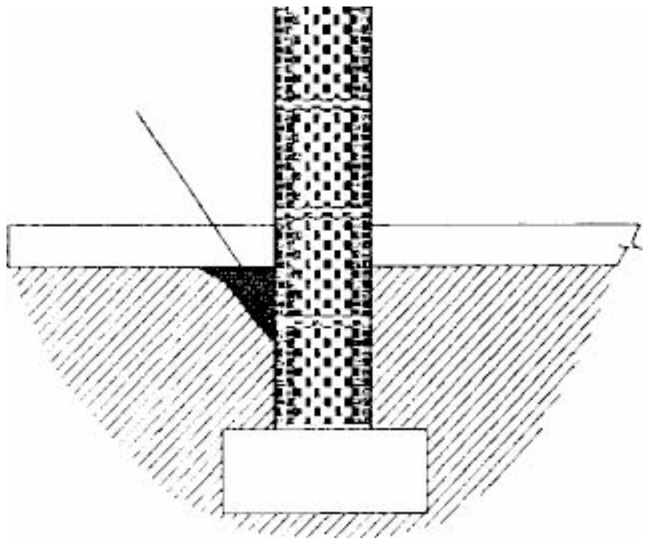


Figure 41. Exterior slab treatment (dark shading indicates treated area)

The amount of chemical that should be applied is determined by the concentration of the formulation used and the rate of application specified on the product label.

Proper, uniform soil treatment eliminates the need for wood treatment except where there is a moisture source that could sustain the termite colony above the soil level.

However, additional wood treatment may accelerate the elimination of infestations.

Foundation treating is the application of termiticide to a foundation to make it impervious to termites. The objective is to place termiticide in all cracks at the footing as well as through cracks in the foundation wall that may lead to the ground outside. Treating the inside of hollow concrete block walls is another example of foundation treating.

Figure 42. A typical basement treatment will also include trenching and rodding the outside perimeter of the foundation.

Pre-Construction Treatment

The easiest time to apply a chemical barrier is before construction, and pre-treatment should be encouraged whenever possible. The soil below all slabs should be treated before they are poured. Treatment should be both under horizontal surfaces and adjacent to vertical surfaces.

The concentration and rate specified on the product label must be strictly followed. It is illegal to use less or more than any rate or concentration specified on the label for pre-construction treatment, including "treatment" or "limited treatment." Many pest-management professionals use a combination of trenching and rodding, especially if the footing is very far below grade level.

Exterior Slab Treatment

An exterior concrete slab that abuts the structure complicates outside treatment. Poured slabs such as sidewalks, patios, and carports should be vertically drilled and treated no more than 12 inches apart. It may be necessary to vary the concentration and volume, as allowed by the termiticide label, to treat thoroughly under slabs.

Exterior Soil Treatment

Soil may be treated by rodding or trenching. Rodding is the injection of termiticide into the soil through a long pipe inserted at appropriate intervals (4 to 12 inches apart, depending on the soil type and other factors). In this way, termiticide can be carried to the level of the footing. Another method for applying termiticide to soil is by trenching. With this method, the soil is removed to within about 1 foot above the footing. As the soil is replaced, it is treated with termiticide at the rate of 4 gallons per 10 linear feet for each foot of depth from grade level to footing. Whenever possible and practical, the soil should be saturated with termiticide to the footing.

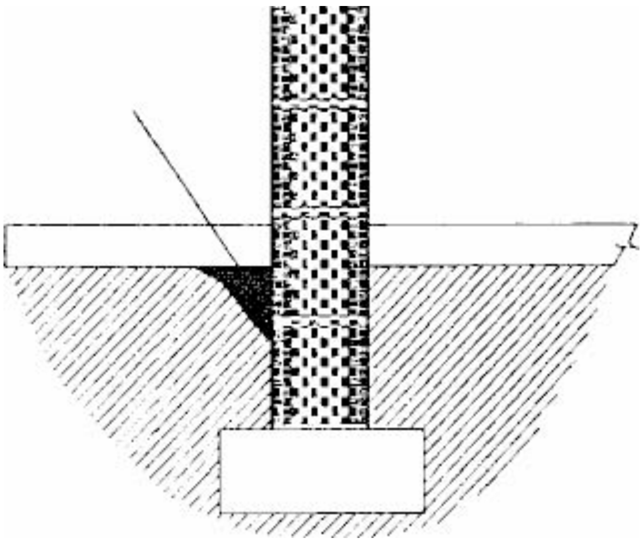


Figure 43. Exterior slab treatment (dark shading indicates treated area)

Construction

Voids in concrete block foundations should be drilled and treated. It is very important that the holes be drilled at a height that is as close to the outside grade level as possible, but not above the slab.

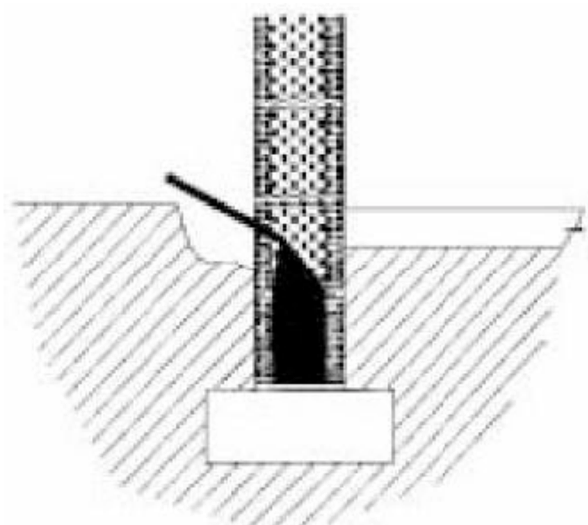


Figure 44. Foundation void treatment (dark shading indicates treated area)

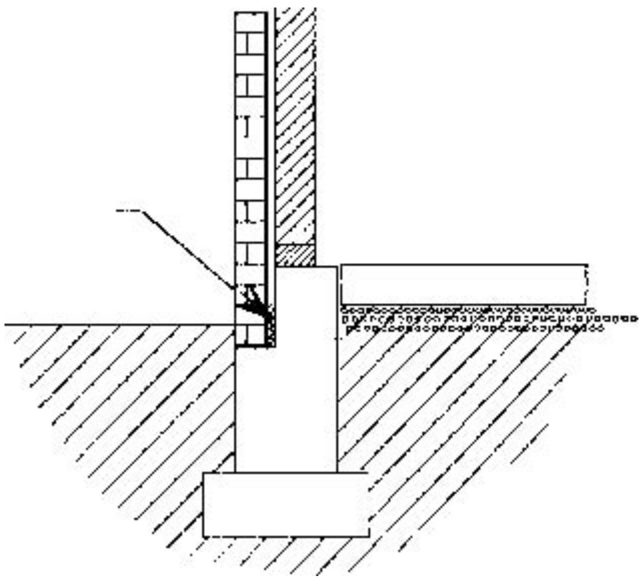


Figure 45. Treatment of brick or stone veneer (arrow points to treatment of void)

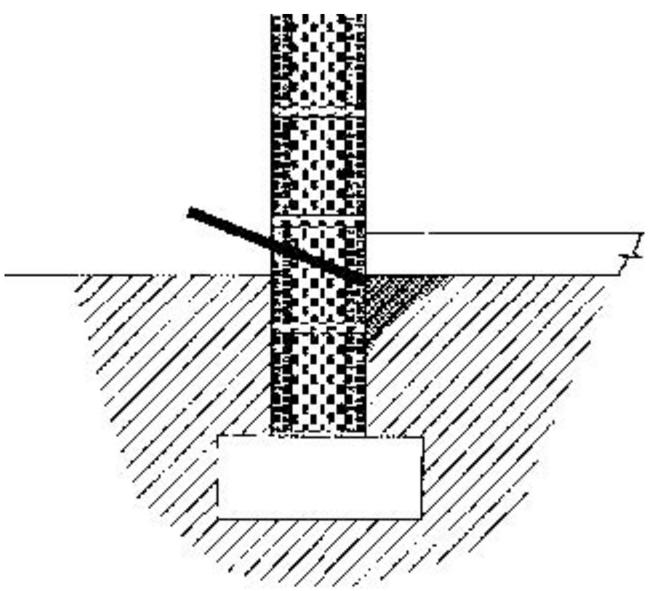


Figure 46. Short rodding (dark shading indicates treated area)

Every void should be treated in the block. In the event of spillage, the area around all leaky drill holes must be cleaned. After cleaning, the holes should be filled to prevent exposure to the building's occupants.

CAUTION: Special care must be taken to ensure that the chemical does not puddle and flow out over the inside slab floor. If the soil line is above the slab line, it may be necessary to trench below the slab line to safely treat voids in blocks at a point of entry below the inside slab line.

Treatment of Brick or Stone Veneer

Voids in brick veneer should be drilled and chemically treated only where the brick ledge is below grade level. Holes measuring approximately 1/4- or 3/8-inch in size must be drilled from the outside into the masonry between bricks, and then the void should be chemically treated. Generally, these holes should be drilled in every other brick. Enough termiticide should be introduced to completely flood the void to the footing or base. The holes should not be drilled above the top of the foundation for basements, or above the level of the interior slab in slab construction, unless the slab is at exterior grade level or lower. Enough pressure should be used to spread the chemical and completely cover the voids. Holes drilled in outside brick walls should be sealed after treatment.

Where it is not possible to drill and treat below the top of the foundation or interior slab level, it may be necessary to trench and treat the soil to below the brick ledge. This method will eliminate the need to drill and treat the void and also reduces the risk of accidental spillage into the interior of the structure.

Interior Treatment Methods

Soil treatment of the inside perimeter of a slab adjacent to the foundation can be accomplished by any one of three methods: vertical drilling, short-rodding or long-rodding.

Vertical Drilling

Vertical drilling is the most common method of interior slab treatment. The slab floor adjacent to the perimeter foundation should be drilled vertically, with holes no more than 12 inches apart. The termiticide should be injected under low pressure so that it will overlap in the soil between holes adjacent to the foundation.

In addition, treatment should be applied along each support wall and wood partition within the structure. In the case of a masonry support foundation that extends through the floor and rests on a footing, it will be necessary to drill and treat any soil adjacent to both sides of the wall. The drill dust should be cleaned up while proceeding with treatment. After treatment, the holes should be plugged up and the surface finished in a manner specified by the customer agreement.

CAUTION: Special care should be taken to identify the location of any heating ducts, water lines and electrical conduits embedded in the slab before beginning treatment to prevent damage, injury and contamination.

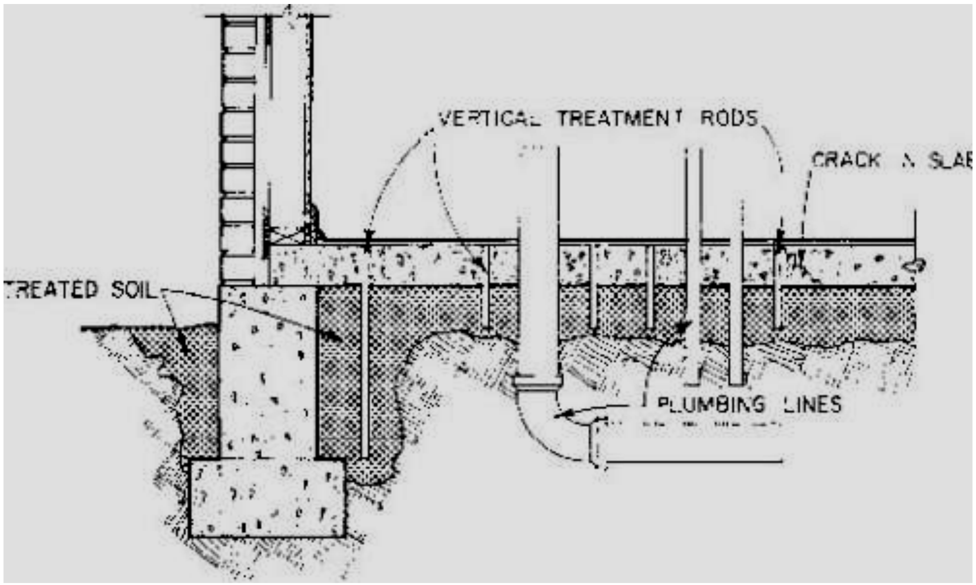


Figure 47. Treatment under concrete with vertical drilling at joints, cracks and openings, and around plumbing

Short-Rodding

Short-rodding refers to a procedure conducted from outside a structure. Short-rodding from the outside may be preferable when no access is available inside. Floor coverings, plumbing fixtures (including bathtubs, sinks and showers), and cabinets or other furnishings may obstruct access to drilling from the inside. Damage to finished flooring inside the structure may prevent drilling through the slab. To reach the subslab soil area, a series of holes should be drilled through the foundation about 12 inches apart, through both sides of the concrete, and into the area precisely below the expansion joint at the edge of the slab. The rod should then be inserted into the area to receive treatment, with the chemical applied under low pressure.

The soil should be saturated as much as possible around the expansion joint area. This will cause the treatment to overlap in the spaces between the holes and produces a continuous barrier. If the holes are spaced apart properly, all the important parts of the structure and the soil interface will receive treatment.

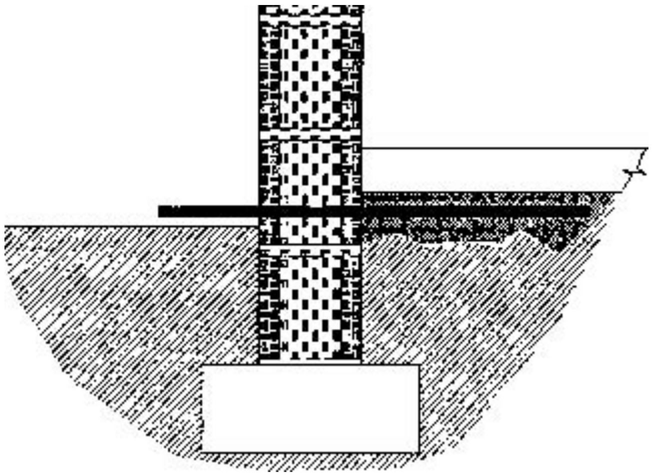


Figure 48. Long-rodding (dark shading indicates treated area)

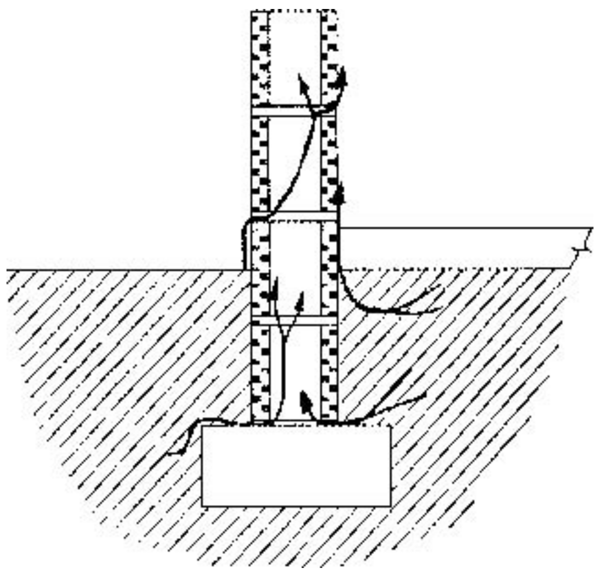


Figure 49. Floating slab block foundation, with arrows indicating possible termite entry points

Long-Rodding

Long-rodding horizontally through the exterior foundation just below the slab level and under the slab adjacent to the foundation is another treatment method for slab construction where the bottom of the interior slab can be accessed. As in short-rodding, it is necessary to determine the precise location of the bottom of the slab to ensure that no untreated soil layer remains above the treatment zone, as well as to allow for easier insertion of the rod for the length of the treatment to be achieved. This method has similar benefits to the short-rodding method, with the added advantage of possible access behind concrete porches. However, long-rodding for any significant distance may leave untreated areas if the rod veers away from the foundation down into the soil.

TREATMENT GUIDELINES: SLAB

Special Cases of Construction

Termite treatment guidelines vary depending on factors such as the type of slab construction, the foundation type, the materials used for the frame walls or flooring, and the termite entry points under certain elements of construction. Described below are some building construction situations that affect treatment guidelines.

Floating Slab Construction with Concrete Block Foundation and Walls

When the walls and foundation are made of concrete blocks, preventing termite entry through block voids is a primary concern. The block voids need to be treated with termiticide below the soil line.

Termite Entry Points

In this type of construction, there are three major entry points. Termites may come from the sub-slab area, up through the expansion joint at the edge of the slab and into the furred wall (as shown), and up through a crack in the floor beneath a wood partition. They may proceed up this space to feed on door jambs, window frames, and even the roof.

Termites can gain access into the concrete block voids and travel upward into the same areas. This allows them access to nearly all of the wooden structural members in the house, as well as any framing and molding. Another less common method of termite entry is from the outside soil, up over the block surface, into a crack or void in the masonry, and upward through the concrete block voids or directly over into the furred wall. This is more common when there is an attached outside slab, such as a sidewalk or carport that abuts the exterior structure, which leaves an expansion joint as well as a protected cover for termite activity.

Treatment Procedures:

- Trench and/or rod exterior soil.
- Drill and treat beneath exterior slabs adjacent to the foundation.
- Treat interior foundation walls by vertical drilling, short-rodding and/or long-rodding.
- Vertically drill and treat adjacent to interior walls and partitions, where necessary.
- Drill and treat foundation voids.

- Treat wood that has accessible termite galleries.
- Repair and plug all drilling holes.

Completion

This composite diagram shows the total protection of the structure by thoroughly treating the voids in the concrete blocks, the soil in the sub-slab area at the expansion joint, and the soil around the outside perimeter of the building. The wood should be treated whenever a need is indicated.

Floating Slab Construction with Concrete Foundation and Brick Veneer on Wood Frame

In this type of construction, treating brick veneer voids to prevent infestation of the wood frame is a primary concern.

Termite Entry Points

A solid concrete foundation eliminates some of the voids that commonly permit termite entry, but termites frequently penetrate up through the slab expansion joint. They will also move from the outside soil area, through the brick veneer, into the void space, and directly into the wood framing.

Less commonly, termites may build tubes up over the exterior brick veneer surface, find openings through the masonry, and gain access to the void space and wooden structural members.

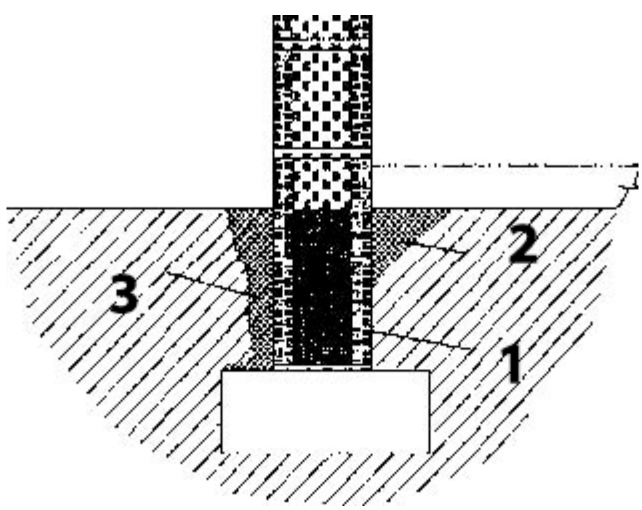


Figure 50. The completed treatment of this floating slab block foundation indicates treatment of:

1. *the voids in the concrete blocks;*
2. *the soil in the sub-slab area at the expansion joint; and*
3. *the soil around the outside perimeter of the building.*

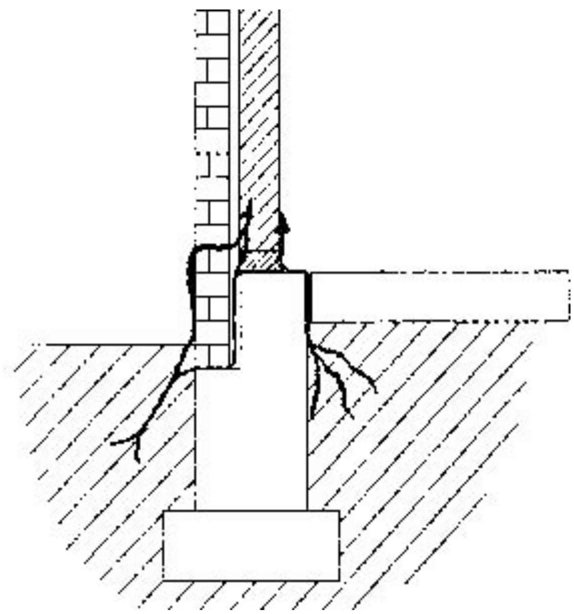


Figure 51. Poured foundation with brick veneer, with arrows indicating possible termite entry points

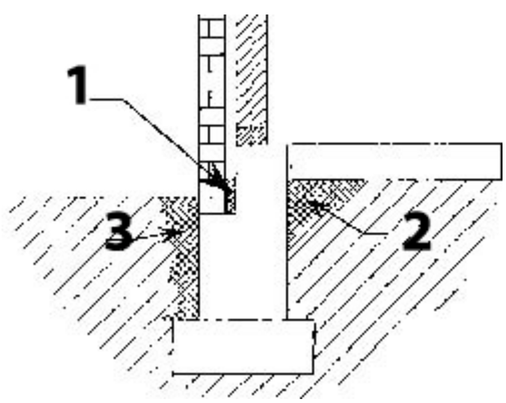


Figure 52. Completed treatment of poured foundation with brick veneer shows treatment of:

1. *the voids in the brick veneer;*
2. *the sub-slab soil area along the expansion joint; and*
3. *the outside perimeter of the building.*

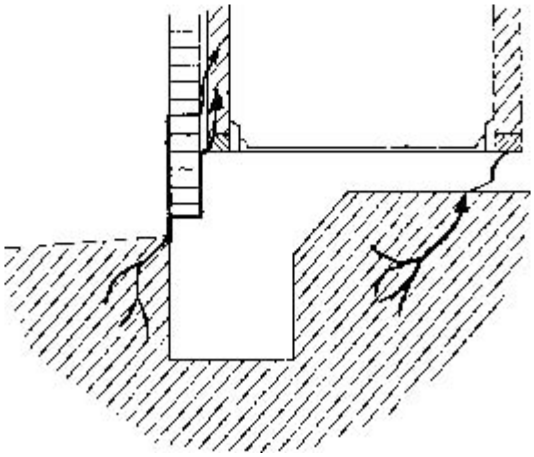


Figure 53. Monolithic slab with tile floor, with arrows indicating possible termite entry points

Treatment Procedures:

- Trench and/or rod exterior soil.
- Drill and treat beneath exterior slabs adjacent to the foundation.
- Treat interior foundation walls by vertical drilling and/or long-rodding.
- Vertically drill and treat adjacent to interior walls and partitions.
- Drill and treat brick veneer voids.
- Treat wood that has accessible termite galleries.
- Repair and plug all drilling holes.

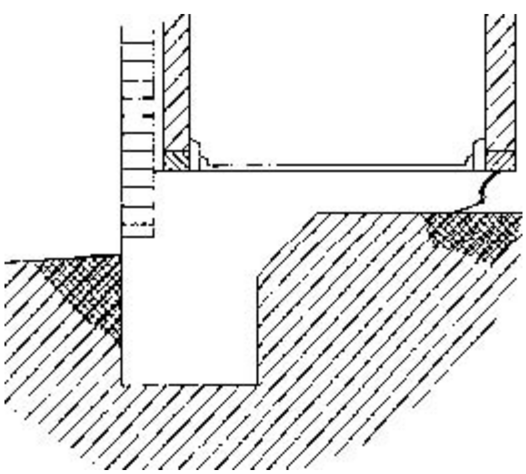


Figure 54. Completed treatment of monolithic slab with tile floor (dark shading indicates treated areas)

Completion

This composite diagram shows the total protection afforded to the structure by thoroughly treating the voids in the brick veneer, the sub-slab soil area along the expansion joint, and the soil around the outside perimeter of the building to a point lower than the bottom of the veneer.

Special Considerations: Monolithic Slabs

Treating soil next to the interior perimeter of the foundation, which is required in almost all other types of construction, may not be necessary in this case. However, soil treatment around the exterior is very important, particularly if there are veneers (such as brick) near the soil line.

Trenching and treating is the most practical method.

Remember that any backfill must also be treated. Rodding does not need to be done because there is no advantage here in deep-soil chemical treatment. Wood treatment is also not required unless there is a specific reason for doing so. No routine treatment of wood is done in monolithic slab construction. When drilling and rodding, caution should be exercised when treating around sewer pipes, heating ducts, plumbing, plenums, electrical wiring, etc.

On monolithic slabs, a careful inspection needs to be made to determine exactly how termites have gained access, as well as to find those areas where they might gain access. The construction of access plates, doors and panels that permit inspection of the entry points of plumbing, bath traps, conduits, etc., constitutes the major part of treatment of this type of structure, together with soil treatment around the outside perimeter.

Wood Over Slab

To treat the soil under a slab covered by a wood floor, both the wood and the slab should be drilled and treated in a checkerboard pattern to ensure adequate coverage. It may also be advisable to treat the wood with borates. The wooden floor may also need to be removed to facilitate treatment. After treatment, all holes in both the slab and wood floor must be plugged and filled.

CHAPTER 4: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

Treatment outside the structure may involve _________ and treating or ________ to treat the soil on the outside of the foundation, rodding beneath slabs, or vertical drilling and treating of outside slabs, stoops or porches.

- (•) trenching..... rodding (correct)
- ( ) drilling..... picking
- ( ) reeling..... nosing
- ( ) slabbing..... crawling
- ( ) inspecting..... covering

T/F: Slab-on-ground construction consists of three types: floating, monolithic and suspended slab.

- (•) True (correct)
- ( ) False

In floating slab construction, the foundation wall and footing are separated from the slab floor by _____________.

- (•) an expansion joint (correct)
- ( ) inserting a containment
- ( ) measuring the separation
- ( ) drilling horizontally
- ( ) at least 3 inches

T/F: Soil treating consists of applying termiticides to the soil under and adjacent to a building to create an impervious chemical barrier.

- ( ) False
- (•) True (correct)

T/F: Foundation treating is the application of termiticide to a foundation to make it impervious to termites.

- ( ) False
- (•) True (correct)

Poured slabs, such as sidewalks, patios and carports, should be vertically drilled and treated no more than _____ inches apart.

- (•) 12 (correct)
- ( ) 6
- ( ) 24
- ( ) 18

It is very important that the holes be drilled at a height that is as close to the _____________ as possible, but not above the slab.

- (•) exterior grade level (correct)
- ( ) sill plate
- ( ) footing
- ( ) interior floor level
- ( ) foundation
- ( ) water table

______-rodding horizontally through the exterior foundation just below the slab level and under the slab adjacent to the foundation is another treatment method used for slab construction where the bottom of the interior slab can be accessed.

- ( ) Medium
- ( ) Vertical
- (•) Long (correct)
- ( ) Short
- ( ) Upper

CHAPTER 5: PESTICIDES FOR TERMITE CONTROL

Pyrethroids

Pyrethroids are a large family of modern synthetic insecticides similar to naturally derived botanical pyrethrins. They are highly repellent to termites, which may contribute to the effectiveness of the termiticide barrier. Pyrethroids have been modified to increase their stability in the natural environment. They are widely used in agriculture, homes and gardens. Some examples include: bifenthrin; cyfluthrin; cypermethrin; deltamethrin; and permethrin. They may be applied alone or in combination with other insecticides. Pyrethroids are formulated as ECs, WPs, Gs and aerosols.

Although certain pyrethroids exhibit striking neurotoxicity in laboratory animals when administered by intravenous injection, and some are toxic by the oral route, systemic toxicity by inhalation and dermal absorption is low. There have been very few systemic poisonings of humans by pyrethroids. Although limited absorption may account for the low toxicity of some pyrethroids, rapid biodegradation by mammalian liver enzymes (ester hydrolysis and oxidation) is probably the major factor responsible. Most pyrethroid metabolites are promptly excreted, at least in part by the kidneys.

In response to dermal exposure, some persons may experience a skin sensitivity called paresthesia. The symptoms are similar to a sunburn sensation of the face and especially the eyelids. Sweating, exposure to sun or heat, and application of water aggravate the disagreeable sensations. This is a temporary effect that dissipates within 24 hours. For first aid, wash with soap and water to remove as much residue as possible, and then apply a vitamin E oil preparation or cream to the affected area.

Paresthesia is caused more by pyrethroids whose chemical makeup includes cyano groups: fenvalerate; cypermethrin; and fluvalinate. In addition to protecting themselves from future exposure, persons who have experienced paresthesia should choose a pyrethroid with a different active ingredient, as well as a wettable powder or micro-encapsulated formulation.

Borates

Borate is a generic term for compounds containing the elements boron and oxygen. Boron never occurs alone naturally but, rather, as calcium and sodium borate ores in several places in the world.

Borax and other sodium borates are used in numerous household and personal hygiene products, such as laundry additives, eye drops, fertilizers and insecticides. While its toxic mechanisms are not fully understood, boron is very toxic to insects and decay fungi that commonly damage wood in structures. However, at low levels, boron is only minimally toxic and perhaps even beneficial to humans and other mammals, as well as growing plants. The use of borate-treated wood for construction of homes and their wood-based contents appears to offer many advantages for today's environmentally sensitive world.

Unlike most other wood preservatives and organic insecticides that penetrate best in dry wood, borates are diffusible chemicals, meaning that they penetrate unseasoned wood by diffusion, which is a natural process. The moisture content of wood and the method and length of its storage are the primary factors affecting penetration by diffusion.

Properly done, diffusion treatments permit deep penetration of large timbers and refractory or difficult-to-treat wood species that cannot be treated well by pressure. The diffusible property of borates can be manipulated in many ways; suitable application methods range from complex automated industrial processes to simple brush or injection treatments.
Application methods include momentary immersion by bulk dipping; pressure or combination pressure/diffusion treatment; treatment of composite boards and laminated products by treatment of the wood finish, hot- and cold-dip treatments and long soaking periods; spray or brush-on treatments with borate slurries or pastes; and placement of fused borate rods in holes drilled in wood already in use.

Organophosphates and Carbamates

These are two very large families of insecticides. Indeed, they have been the primary insecticides for the past 25 to 30 years. They range in toxicity from slightly to highly toxic. They are formulated in all kinds of ways, from highly concentrated ECs to very diluted G formulations.

These insecticide families are similar in their modes of action. They are all toxic to the nervous system. Insects and all other animals, including humans, have nervous systems that are susceptible. Both insecticide families are efficiently absorbed by inhalation, ingestion and skin penetration. To a degree, the extent of poisoning depends on the rate at which the pesticide is absorbed. Organophosphates break down chiefly by hydrolysis in the liver; rates of hydrolysis vary widely from one compound to another. With certain organophosphates whose breakdown is relatively slow, significant amounts may be temporarily stored in body fat.

The organophosphates and carbamates replaced the chlorinated hydrocarbons (chlordane, aldrin and heptachlor) for all uses, including termite control. Examples of organophosphates are chlorpyrifos for termite control, and diazinon for other household pests. An example of a carbamate is Carbaryl (Sevin®), also used for household and lawn pests. The pyrethroids are gaining significantly in some aspects of termite control.

Nicotinoids

Nicotinoids are similar to and modeled after natural nicotine. Imidacloprid is an example of this type of chemistry that is used as a termiticide. Imidacloprid was introduced in Europe and Japan in 1990 and first registered in the U.S. in 1992. Imidacloprid acts on the central nervous system of termites, causing irreversible blockage of post-synaptic nicotinergic acetylcholine receptors. Imidacloprid is registered for use as a termiticide under the name Premise®. It is non-repellent to termites and has contact activity, as well as activity as a stomach poison.

Pyrroles

Chlorfenapyr is the only termiticide from the pyrrole family of chemistry and is active primarily as a stomach poison, with some contact activity. It is also non-repellent to termites. Chlorfenapyr is registered as a termiticide under the trade name Phantom®. Chlorfenapyr acts on the mitochondria of cells and uncouples or inhibits oxidative phosphorylation, preventing the formation of the crucial energy molecule adenosine triphosphate (ATP). As a result, energy production in the cells shuts down, resulting in cellular -- and, ultimately -- termite death.

Fiproles (or Phenylpyrazoles)

Fipronil is the only insecticide in this new class, which was introduced in 1990 and registered in the U.S. in 1996. It is marketed as a termiticide under the trade name Termidor®. This termiticide is a non-repellent material, with contact and stomach activity. Fipronil works by blocking the GABA- or gamma-aminobutyric acid-regulated chloride channel in neurons, thus disrupting the activity of the insect's central nervous system.

Insect Growth Regulators

An insect growth regulator (IGR) is a synthetic chemical that mimics insect hormones. Hormones regulate a wide array of body and growth (physiological) functions. Some examples include interfering with molting, interfering with pupal emergence, and interfering with body wall formation.

IGRs are often specific for an insect species or group of very closely related species. They often have delayed effects because they are taken into the insect and stored until the insect reaches the right growth stage. This may range from days to weeks or even months. For example, if the IGR stops the insect from molting, and a given insect is exposed just after a molt, it would continue to function normally until the next molt before dying.

In the case of termite control, the slow action of the IGR allows the chemical to be widely spread throughout the colony as the termite workers feed and groom each other.

The IGRs are, in general, environmentally safe and have very low mammalian toxicity. Some examples include: noviflumuron; hexaflumuron; pyriproxyfen; and methoprene.

Biological Agents

Biological control agents, such as disease-causing fungi and bacteria and parasitic nematodes, are being studied as possible options for termite control or reduction. In some cases, these agents are released into the soil; in other cases, they are injected into the above-ground termite galleries. As with all new methods of control, more research is needed to determine the advantages and limitations of such organisms. "Bt" or *Bacillus thuringiensis* is an example of a commonly used biological control agent.

CHAPTER 6: BAIT, FOAM AND FUMES

There are several termite baits on the market that add to the arsenal of tools available for managing termite populations and protecting structures. Baits work on the principle that foraging termites will feed on a treated cellulose material, which eventually kills the termites and possibly the colony. The toxic material in the bait must kill slowly enough to allow foraging termites to return to the colony and spread the bait through food sharing (trophallaxis). Because dead termites repel other termites, the toxic material also must kill slowly enough so that dead termites do not accumulate near the bait.

Baits control a colony locally by either eliminating it or suppressing it to the point that it no longer damages a structure. To be successful, the products must be non-repellent, slow-acting, and readily consumed by termites.

There are three main types of bait products available:

1. ingested toxicants or stomach poisons;
2. biotermiticides or microbes; and
3. insect growth regulators (IGRs).

Each type has unique features and is used differently in termite control programs. Ingested toxicants have the quickest effect. However, dose-dependency and learned avoidance may limit this type of product to termite reduction in localized areas.

Biotermiticide, which is derived from fungi, bacteria or nematodes, works by being injected into active gallery sites. It then develops on the infected foraging termites and spreads among the colony. Suitable temperature and moisture, early detection and avoidance are factors that determine this treatment's success. It may provide localized area control or, with optimum conditions, may suppress a colony.

Among the insect growth regulators are juvenile hormone analogs (JHA), juvenile hormone mimics (JHM), and chitin synthesis inhibitors (CSI). These products disrupt the termites by causing a specific response or behavior within the colony or by blocking the molting process. Remember that all insects, including termites, have an exoskeleton made primarily of chitin. In order to grow, they must periodically shed their chitinous exoskeletons and form new ones. This process is called molting. A chitin synthesis inhibitor slowly builds up in the termite and, the next time a molt should occur, prevents proper formation of the cuticle. IGRs are the slowest of the bait types but have greater impact on the colony,

Some of the major baits available to the pest control industry are discussed below. Note their use for either colony elimination or for colony suppression.

Commercial Baiting Products

The Sentricon™ System, developed by Dow AgroSciences for professional use, combines monitoring with the use of permanent stations. Stations are installed in areas where termites exist, around the perimeter of a structure and in the yard. Each station contains a wooden stake and must be periodically monitored for termite activity. After termites attack, the stake is removed and replaced with a bait tube. Termites from the stake must be transferred to the bait tube, which is left in the station until termite activity ceases. Then the bait tubes are replaced with new wooden stakes and monitoring for new infestations resumes. Thus, the Sentricon™ System protects property through an integrated program of monitoring, baiting when termites are present, and resuming monitoring when termites are no longer present. The active ingredient in the Sentricon™ System is hexaflumuron, a chitin synthesis inhibitor. The philosophy behind the Sentricon™ System is that foraging pseudergates will feed on the bait, return to the colony, and pass the bait to other colony members through trophallaxis. Dow AgroSciences claims that with the Sentricon™ System, colony elimination is possible.

FMC Corporation manufactures bait stations for the suppression of subterranean termite colonies. The FirstLine™ Above-Ground Termite Bait Station is applied directly to active termite infestations. It is placed above ground, inside or outside, at the leading edge of active termite mud tubes. Another product, the FirstLine™ GT In-Ground Bait Station, is placed in the ground in areas conducive to termite attack and acts as a first line of defense against termite invasion of a structure. There are two types of these in-ground bait stations. One type employs wooden stakes for monitoring the presence of termites. The other type uses cardboard treated with sulfluramid. Bait stations are placed in areas where termites are present or very close to monitoring stations that have been attacked by termites.

The active ingredient in FirstLine™ termite bait stations is sulfluramid, a slow-acting stomach poison. The theory behind the FirstLine™ products is that many termites will feed on the bait and, over time, will die. Research with these bait stations demonstrates that reduction of the termite population is possible, but not elimination.

FMC Corporation also markets Interceptor™, an on-the-wall application. This product is placed over a termite tube. The tube is broken open to allow termites to have access to the bait. The active ingredient is sulfluramid.

Ensystex Incorporated manufactures a termite baiting system called Exterra® Termite Interception and Baiting System. The in-ground stations are designed to permit visual inspection without removing or disturbing the stations. The chitin synthesis inhibitor diflubenzuron (Labyrinth®) is the active ingredient in the bait matrix, a shredded paper towel material.

BASF manufactures Subterfuge® termite bait, with hydramethylnon as the active ingredient mixed into bait matrix. This baiting system places the active ingredient in the ground at the same time that the station is placed in the ground. Hydramethylnon is a member of the amidinohydrazone family of chemicals and is primarily active as a stomach poison. It is also non-repellent to termites. It works on the mitochondria of cells and ultimately shuts down energy production, resulting in death in a manner similar to chlorfenapyr.

An example of a biotermiticide is BioBlast™, manufactured by EcoScience. BioBlast™ is an EPA-registered wettable powder containing live spores of the insect-killing fungus *Metarhizium anisopliae*. This product is injected into the termite galleries. The spores germinate, penetrate the cuticles of termites, and kill them. Spores are carried throughout the colony in a manner known as "horizontal transfer." BioBlast™ controls termites in localized areas if conditions are right for the fungus to grow.

Summary of Bait Technology

When deciding whether to use baits, it is important to remember that this is a relatively new technology. Baits are still being evaluated and their long-term success is unproven. However, the concept of controlling termites with baits is promising. The termite control professional must determine which approach -- colony elimination or suppression -- has the best chance of succeeding in each situation.

Baits may require anywhere from a few weeks to several months to produce noticeable termite control, depending on such factors as the product selected, application timing, the time of its discovery by the termites, the amount of feeding the colony does, the colony size, and other control measures used.

Baits fit well in an integrated pest-management (IPM) control program, along with eliminating conditions conducive to termite infestation, judicious use of liquid soil products as a spot or limited barrier application, and use of wood-treatment products. An IPM program requires more frequent visits to the site for monitoring and to provide ongoing service.
Pest management professionals are strongly encouraged to familiarize themselves with bait technology, trends and products.

Foaming Agents

Foam formulations of soil-applied termiticides can deliver termiticide to areas that are difficult to reach with liquid formulations. Borates are foamed for application in wall voids. Foams penetrate into hard-to-reach cavities and voids, and they improve termiticide distribution in soils. The most difficult area to achieve uniform and continuous insecticide distribution is under slabs, where the termite control specialist is unable to see the actual deposition of the termiticide.

Foam applications can reduce the need for corrective treatments, especially under slabs. The liquid termiticide is combined with air to create uniform, small-diameter bubbles. The foam carries the liquid termiticide in the spaces between the bubbles. As the foam breaks down, it leaves a thin residue on the surfaces it comes into contact with.

The fact that foam is less dense than liquid enables it to dispense uniformly. The foaming agent delays collapse of the bubbles, providing more time for the insecticide to reach desired areas. Underneath a slab, gravity deposits most of the liquid on the soil, with a small portion of the residue on other surfaces (such as the underside of a concrete slab) in the treated areas.

Foam treatments do not replace other soil applications (they supplement these applications so that gaps left by conventional treatments can be successfully treated. Foams are being used to treat - or retreat - critical areas such as unevenly filled porches, which liquids might not reach or cover uniformly. Foams may be used in initial treatments to ensure the most complete termiticide barrier in critical as well as hard-to-reach areas, thus reducing the treatment failures that may occur with the use of soil-applied termiticides alone.

Fumigation

Pests that can be treated with fumigation include drywood termites, anobiid powderpost beetles (usually in softwoods such as floor joists, etc.), lyctid powderpost beetles (in the sapwood of hardwoods such as moldings, cabinets, and flooring), and old house borers (in the sapwood of softwoods in beams, rafters, etc.).

Advantages of Fumigation

Fumigation has several advantages over other pest control procedures:

- Fumigants are usually quick-acting and eradicate the pest.
- Fumigants diffuse through all parts of the structure or commodity being treated and thus reach pest harborages that cannot be reached with conventional pest control materials or techniques.
- For certain pests/commodities, fumigation is the only practical method of control.

Disadvantages of Fumigation

For several reasons, fumigation may not be the best means of pest control, including:

- The control achieved through fumigation is temporary.
- There is no residual action from fumigants, and as soon as the fumigation is completed, the structure or commodity is susceptible to re-infestation.
- Fumigants are toxic to humans, and special precautions must be taken to protect fumigators and the occupants of fumigated structures.
- Fumigants must be applied in enclosed areas, so application requires additional labor. Fumigation must not be attempted by one person.
- Some commodities or pieces of equipment may be damaged by certain fumigants and must be removed or protected.
- The special training required for all members of the fumigation crew adds to fumigation costs.
- Occupants of the structure being fumigated usually must vacate the building for a number of hours. This may be inconvenient.
- Fumigation requires special licenses and certification.

CHAPTER 6: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

T/F: Pyrethroids are a large family of modern synthetic, highly termite-repellent insecticides that are similar to naturally derived botanical pyrethrins.

- True (correct)
- False

T/F: Borate is a generic term for compounds containing the elements boron and oxygen.

- True (correct)
- False

T/F: Insect growth regulators (IGRs) are generally environmentally safe and have very low mammalian toxicity.

- False
- True (correct)

_________ work on the principle that foraging termites will feed on a treated cellulose material, which eventually kills the termites and possibly the colony.

- Baits (correct)
- Batting products
- Chemical injections

_________ penetrate into hard-to-reach cavities and voids, and improve termiticide distribution in soils.

- Foams (correct)
- Sealants
- Fumes
- Drills

There is no residual action from ________, meaning that as soon as the fumigation is completed, the structure or commodity is susceptible to re-infestation.

- foaming agents
- sealants
- fumigants (correct)

CHAPTER 7: TREATMENT OF CRAWLSPACES

Treatment Guidelines for Crawlspace Construction

All cellulose-containing trash and debris must be removed from the crawlspace to aid in proper treatment, to reduce the chance of future attacks, and to aid in future inspections. The soil adjacent to both sides of the foundation and the support walls and around piers, plumbing lines, and other points of access should be treated by trenching and/or rodding.

If the foundations or piers have hollow voids, these areas also must be treated to prevent termite access through cracks in the footing. The soil beneath exterior porches next to the foundation should be treated by vertical drilling, horizontal rodding, or excavation to gain access for treatment.

To control infestations occurring along interior walls and around supporting piers of houses with crawlspaces, a trench 6 to 8 inches wide and a few inches deep should be dug next to the walls and piers, taking care not to go below the top of the footing. When the top of the footing is exposed, the commercial pesticide applicator must treat the soil adjacent to the footing to a depth not to exceed the bottom of the footing.
If the land slopes or if the footing is more than 12 inches deep, holes should be made in the bottom of the trench about 1 inch in diameter and a foot apart. The holes should go to the footing, which will help distribute the chemical evenly along the wall.

The trench along the exterior foundation wall should also be made 6 to 8 inches wide, and up to a foot deep. If needed, holes should also be made in the bottom of the trench, as described for the trench along the interior wall.

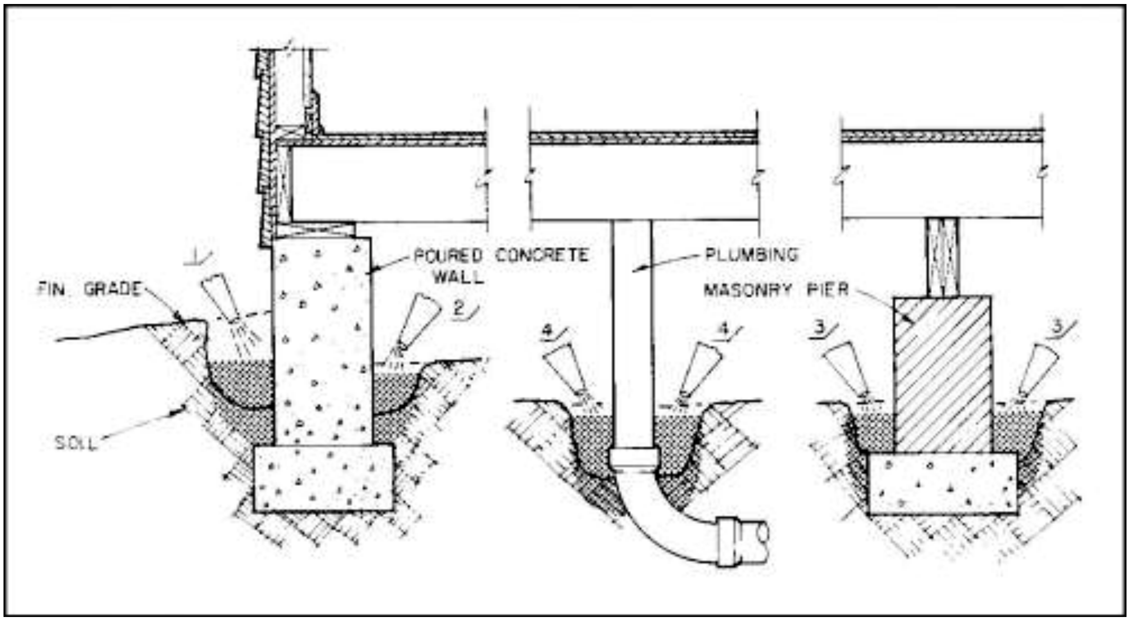


Figure 55. Application of chemical to crawlspace construction/soil treatment should be made:
1) along outside of the foundation wall;
2) along the inside of the foundation wall;
3) around the pier; and
4) around the plumbing.
(Graphic adapted from USDA)

CHAPTER 8: TREATMENT OF BASEMENTS

Treatment Guidelines for Basement Construction

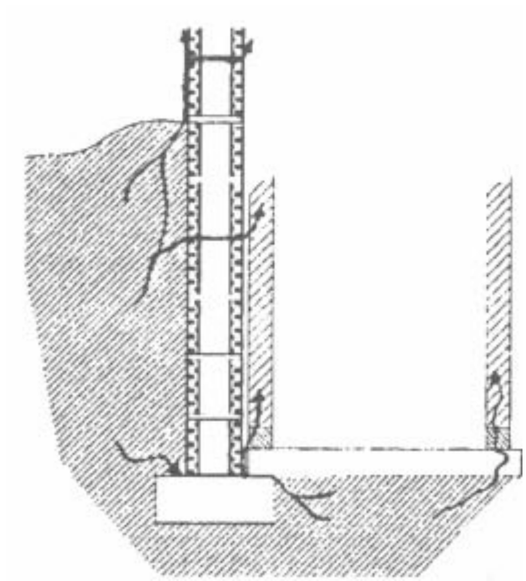


Figure 56. Basement construction, with arrows indicating potential entry points for termites

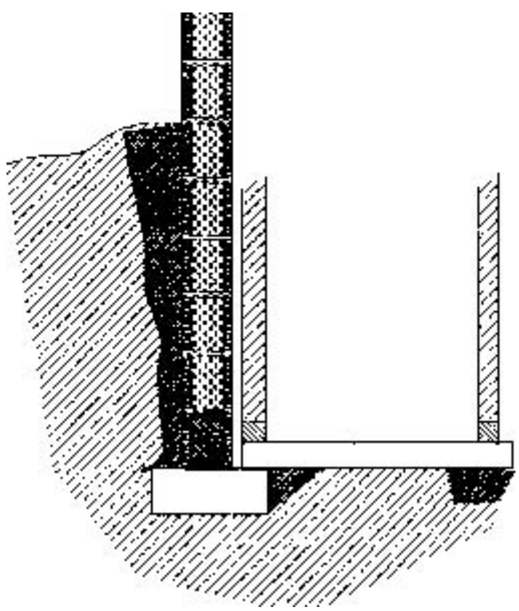


Figure 57. Completed treatment of basement construction (dark shading indicates treated areas)

Where termites have been detected to be entering a structure from beneath the concrete floor in a basement, any wood that may extend into the ground must be removed so that the soil can be treated, and then any cracks and holes must be sealed using a dense cement mortar. When the infestation is located between the floor and wall (in an expansion joint) or around a furnace, a series of holes must be made, spaced about 1 foot apart, through which a chemical can be poured or injected. Holes along a wall should be made about 6 to 8 inches from it so as to clear the footing and reach the soil beneath.

When the infestation occurs along the exterior foundation wall in a house with a full basement, it is necessary to treat the soil to a greater depth than is required for other types of houses. The trench should be prepared in the same way, but the pipe or rod holes should extend down to the top of the footing to aid in proper distribution of the chemical to all parts of the wall. This is especially important in masonry foundations with numerous mortar joints below grade that may be susceptible to termite attack.

Treatment Procedures

- Trench and/or rod the exterior soil.
- Drill and treat beneath the exterior slabs adjacent to the foundation.
- Treat adjacent to the interior foundation walls by vertical drilling.
- Vertically drill and treat adjacent to the interior partition walls, where necessary.
- Drill and treat any brick veneer voids.
- Drill and treat any foundation voids.
- Treat wood that has accessible termite galleries.
- Repair and plug all drilling holes.

Completion

The composite diagram (Figure 36) shows the total protection afforded by completing the recommended treatment procedures.

Special Considerations for Basements

The soil treatment techniques for basements are the same as described for floating slab construction on the exterior and interior of the structure. If treatment of the exterior soil to the top of the footing is not possible or practical, it will be necessary for the pest management professional to indicate clearly to the client that the treatment is considered either a “spot treatment” or “limited treatment.” Brick and stone veneer should be drilled and treated only if it extends below grade level, and then treatment should be made only below the top of the foundation wall to prevent accidental contamination of the interior. Hollow foundations should be treated from the interior in the presence of unfinished walls, and then only at the bottom course of block just above the basement's floor level. In the case of a block, rubble or other masonry foundation wall construction with interior finished walls, extreme caution should be used in treating exterior soil and voids in the foundation to prevent the termiticide from seeping into and contaminating the structure.

Re-Treatments for Soil-Applied Termiticides

Pest-control professionals should never make routine or annual re-treatments. Re-treatments are generally performed only if there is evidence of re-infestation, if the initial treatment was inadequate, or if the chemical barrier has been broken by moving soil around the structure. The re-treatment is normally a partial treatment in the areas of infestation or soil disturbance, and should be recorded as a partial or spot treatment on the statement of services.

Termite Calculation Problems and Solutions

Use of a termiticide involves determining the area to be treated in linear feet or square feet. In some cases, both measures must be determined, depending on the type of treatment (pre- or post-construction) and construction features. Examples are provided in this course that illustrate methods of calculating area and linear measure, as well as linear measure per foot of depth. The examples are illustrations only and are not given as values to be used in determining the volume of water emulsion or solution needed to treat a structure of similar shape and dimension because construction features may vary from site to site. These samples are provided to assist with the interpretation of real pesticide labels and with calculation of the right amount of pesticide to be applied to a given area. These problems can be solved using the termiticide label's guidelines.

Termite Entry Points

Typical entry points to basements are marked. These will be the same as in a floating slab construction: up through the slab expansion joint or from the outside soil area through the brick veneer. They may also come up from cracks in concrete slabs and into wooden support members.

Summary

Whenever possible, pre-construction treatment to prevent termite infestations is the best method for controlling termite problems. Whenever pre- or post-construction treatment is needed, the pest management professional must be aware of the various aspects of building construction to apply termiticide to the appropriate places. The goal is to establish a continuous chemical barrier that will eliminate the termite colony and prevent re-infestation.

CHAPTER 9: OTHER TREATMENTS FOR TERMITES

OTHER TREATMENTS FOR SUBTERRANEAN TERMITES

After successfully completing this section, you should:

- Know the difference between plenum and non-plenum crawlspaces and how they should be treated for termite control.
- Know how to locate sub-slab heating ducts and how to prevent termiticide contamination of the air flowing through the ducts.
- Be familiar with situations in basements that require special consideration when applying termiticide and know how to treat each.
- Know the avenues of termite entry for a dirt-filled concrete porch on a frame house, and how to control termites in that area.
- Know what should be done to prevent and control termite entry in the case of wooden porches.
- Know how to prevent leaking of termiticide through hollow-block, tile, and rubble foundations.
- Know how termiticide should be safely applied to soil when wells, cisterns and other water sources are located on a property.
- Know how to control termite infestations when rigid foam insulation board is present.
- Know what wood treatments are available when soil treatment is not possible in a structure.

Certain features of building construction require special consideration when a professional is attempting to control termites.

In some situations, it may be advisable not to treat with liquid termiticides but to use some other method, such as termite baiting, borates, or mechanical alteration. This is particularly true when liquid termiticides might cause contamination of air-handling systems or water sources. If a structure or an area may pose problems in treatment, it is advisable for one person to be inside to monitor the application while another professional performs the exterior treatment of the soil, brick veneer, hollow-block, or rubble foundation.

Plenum and Non-Plenum Crawlspaces

Several types of construction are extremely difficult (and occasionally impossible) to treat with termiticides. The plenum concept uses the area under the sub-floor (the crawlspace) as a giant heating-cooling duct. There are no vents or access doors in the foundation; thus, termiticide odor can be circulated with heated or cooled air through the structure. Therefore, treatment using conventional liquid termiticide is not recommended. Termite baits may be an option for treating plenum housing.

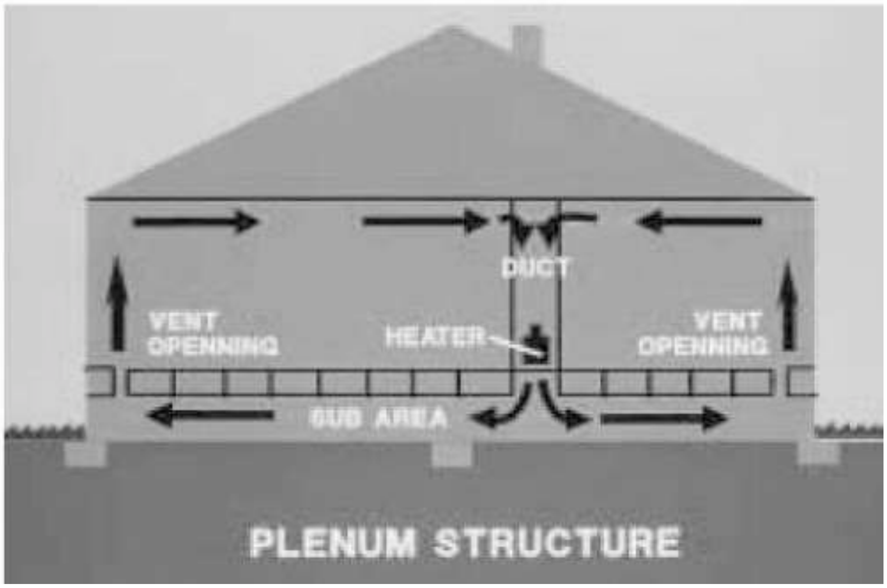


Figure 58. Plenum houses use the area under the subfloor as a giant heating-cooling air chamber. Because of this, use of conventional liquid termiticide is not recommended.

In non-plenum structures, air ducts in the crawlspace area should be examined before treatment. If breaks or leaks at joints are found, they should be repaired before treatment is administered. Some air-handling units are located in crawlspaces and draw air from that area. They should be ducted to draw in air from outside the structure before treatment. It is also recommended that all crawlspace areas be adequately ventilated to prevent the buildup of odor and airborne termiticide residue. If a structure has inaccessible crawlspace areas within the foundation, access will have to be created. Professionals should visually inspect the area to determine the best method of treatment.

If there is sufficient clearance, treatment should be made as in any other crawlspace area. If there is insufficient clearance between the floor joists and the soil, soil should be removed for sufficient access to treat the area.

It may also be acceptable to drill the floor and treat the crawlspace area by rodding. It may also be horizontally drilled and rodded. The treatment area should be vented, if possible.

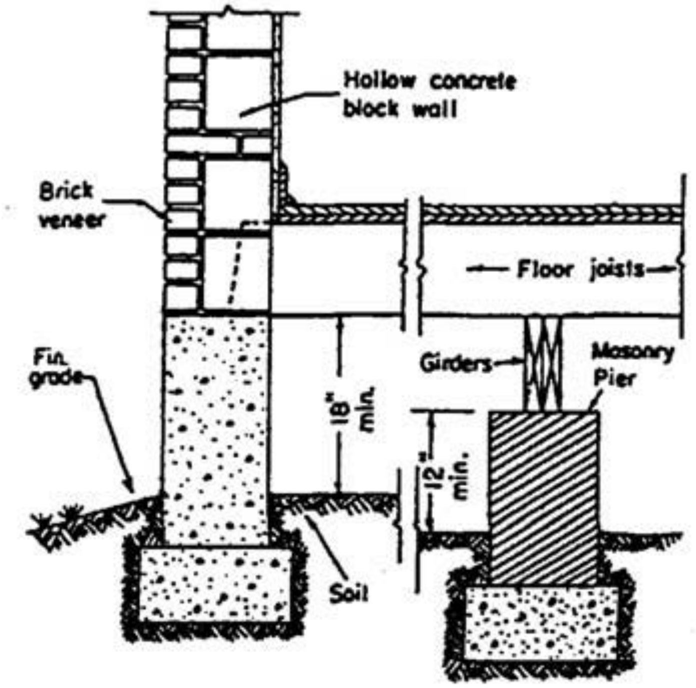


Figure 59. Where the superstructure of a building is masonry, adequate clearance should be provided between the wooden members and the ground both outside and inside the building. (Graphic adapted from USDA)

Sub-Slab Heating Ducts

Another common type of construction that requires special consideration in the treatment for termites is houses with heating systems under or embedded within the concrete slab of the structure. The accidental introduction of a termiticide into the ducts can result in a serious contamination of the air that flows through them and into living quarters. Termite baits may be an effective alternative in these situations.

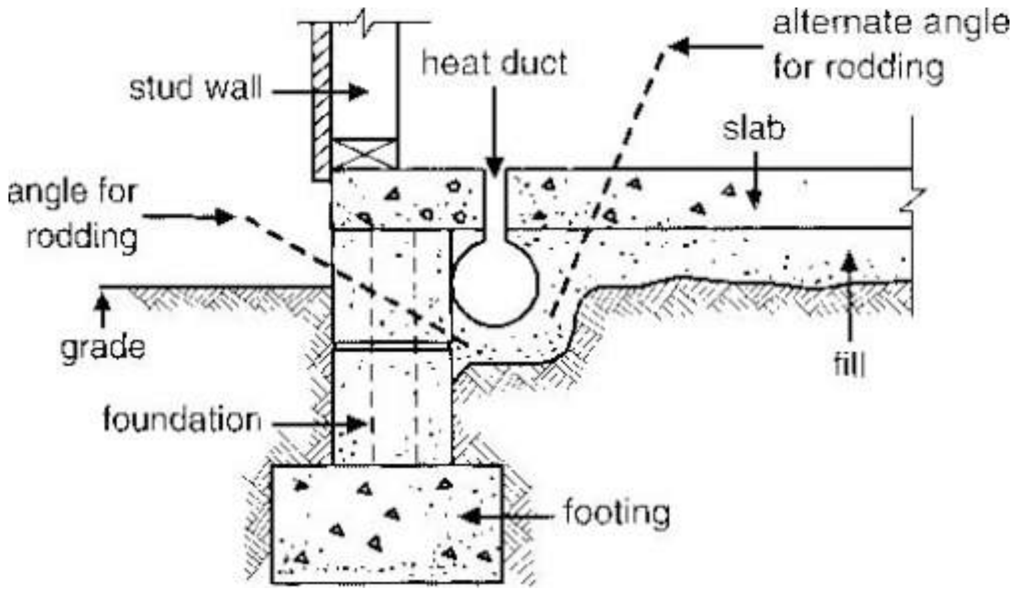


Figure 60. Rod treating adjacent to a perimeter heat duct

Ducts should be inspected as thoroughly as possible using a mirror and a flashlight. If it appears that the ducts are made of material containing cellulose, or if they have soil or sand bottoms, or if they contain standing water, or if they are not properly sealed, the professional should reconsider treatment. Such ducts should be sealed with concrete and an alternative air-handling system installed before treatment. To locate ducts in slabs, the heating system should be turned on and damp newspapers placed over the suspected location of the ducts. The newspapers will begin drying in the areas immediately over the ductwork. (This will not work on carpeted floors.)

Applying termiticide under or around the ducts must be done carefully. Greatly reduced pressure (less than pounds at the nozzle tip) or gravity (percolation) methods should be used. The use of a sub-slab injector should be limited. If holes are drilled in the interior slab, knowledge of the exact location, directions of the system, and depth and width of the ducts is important.

If possible, the pest management specialist will want to apply the chemical under the ducts. Reducing the pressure will keep the termiticide from backing up into the duct. Rodding from the outside by drilling the foundation and running a rod in under the ductwork may be the best treatment procedure. Again, knowing the depth of a duct in or under the slab is essential so that the drill or rod does not puncture the duct. Horizontal rodding under the slab is the correct procedure where radiant heat pipes are embedded in the slab of the structure.

After drilling is completed but before treatment is applied, all vents must be closed. The fan for the air system should be turned on. Each hole should be checked for air flow. If air flow is detected, the holes should be plugged without treating them. It is also essential that periodic checks are made during treatment and immediately after treatment for signs of contamination. The heating system should be turned on and checked for odors. If an odor is present, the unit should be shut off and the cause of the odor determined.

Odors could be coming from the moist, treated soil beneath the slab. If this is the case, the odors will usually not be strong and should persist for only a day or two. Charcoal filters in heat registers can be used to minimize odors.

If a strong odor persists, there is probably a termiticide deposit in a duct. This must be cleaned out. An industrial wet-vac is the best method for removing any liquid from the ducts, and charcoal filters should be used over heat registers. Removal of the deposit may require expertise in chemical de-activation. Termiticide manufacturers all have de-activation and odor-control information available, and they should be contacted for up-to-date recommendations.

Special Considerations for Treating Basements

French drains in basements can pose a problem for effective termite treatment. French drains are used to drain water into a sump, storm sewer or other area. They are usually found around the perimeter of a finished basement. The professional may want to drill test holes before proceeding with treatment. If there is a sump pump, it should be turned off and the sump inspected. If water is present, some of it should be removed to observe the water level for a few minutes. If the level of the water rises, treatment should be delayed until a time when the soil is drier. The sump should also be observed during the course of treatment for the presence of termiticide. If termiticide is present, the contaminated water should be removed and disposed of in a safe and legal manner.

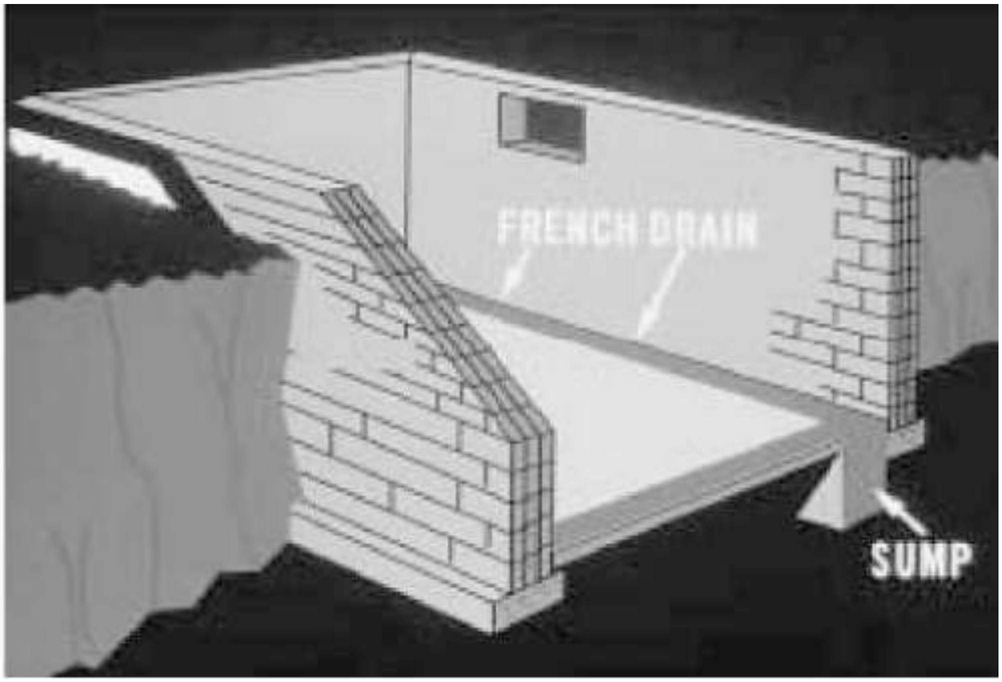


Figure 61. A French drain is a below-grade drainage system that is level with or beneath the basement floor and usually runs around its perimeter. When water gets into the basement, it goes through the French drain and runs into a sump, or sometimes outdoors.

Figure 62. If the basement has a sump pump, care should be taken to avoid getting chemical into the sump or pit in which the pump sits. This is important because sump pumps usually discharge into non-target areas, such as a driveway, street gutter or underground sewer.

One of the most common problems in the control of subterranean termites is a wooden member that extends through the concrete in the basement floor. Supporting posts, stair risers, and door frames are common examples. To correct this, the wooden members should be cut at least 4 inches above floor level, then the portion that extends through the floor should be removed. The soil underneath should be thoroughly treated with termiticide, and then concrete should be poured into the hole and into a form extending to the remaining portion of the wooden members for support. In the case of stairways, it is advisable to make the entire lower step out of concrete, if possible. It is generally undesirable to attempt to treat buried wooden supports by chemical means alone.

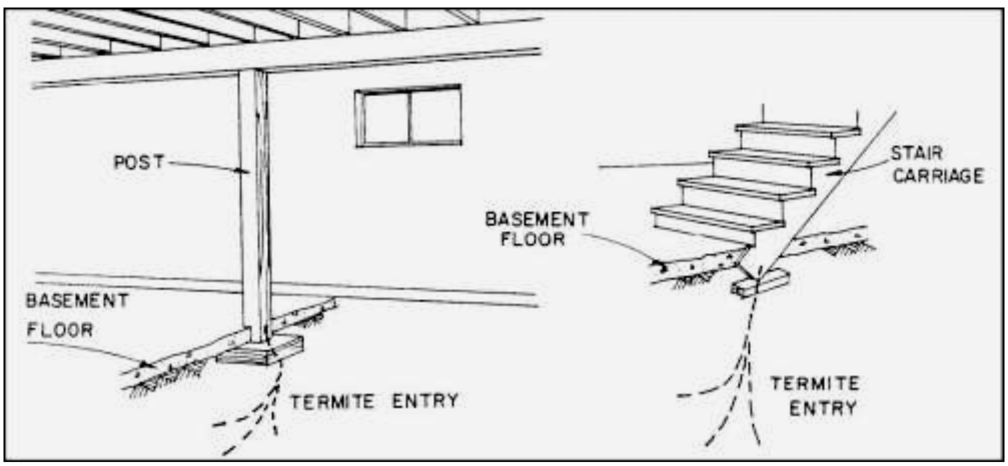


Figure 63. Wood post and basement steps extending through concrete (graphic adapted from the NPMA)

Before treating in basements, the foundation walls should be inspected for cracks where seepage of termiticide may occur when the soil outside is treated. If the foundation wall contains cracks or void areas, or if inspection cannot be made, a second professional should be in the basement to watch for any leakage through the wall while the soil outside is being treated. The basement walls should also be checked when treating the front and back porches to be sure that the termiticide does not seep over the sill plate. If the basement has an exposed soil floor, the treated area should be covered with 2 to 4 inches of untreated soil or other impervious barrier after treatment is completed.

Concrete block foundation walls that extend down through the basement floor present a special problem. The usual practice is to drill holes through the floor on both sides of the wall and treat the soil underneath. Basement windows, with or without outside window wells, pose another problem.

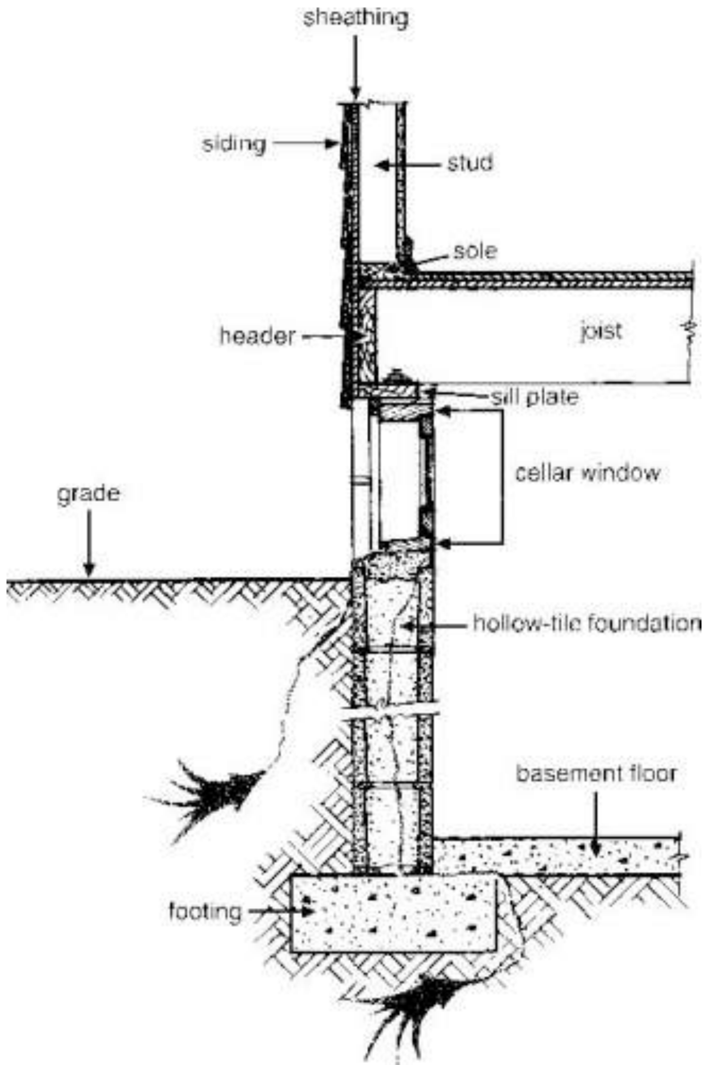


Figure 64. This is an example of a concrete block foundation with basement window. Avenues of termite access are indicated by the heavy arrows in the soil (NPMA).

Normally, the windowsills are close to the ground. If the sills are made of wood, they provide a good source of food for termites. They are also subject to rot. Ideally, wooden sills should be replaced with concrete. Walls with voids in them should be treated with termiticide, starting as close as possible beneath the window to ensure thorough coverage.

The ground outside the window should also be treated. Ideally, window wells should be floored solidly with concrete, but they may be treated with termiticide by rodding next to the foundation.

Dirt-Filled Concrete Porch on a Framed House

This is a common type of construction throughout the U.S., and the principles involved apply to stoops and poured outside slabs at ground level, such as sidewalks and driveways.

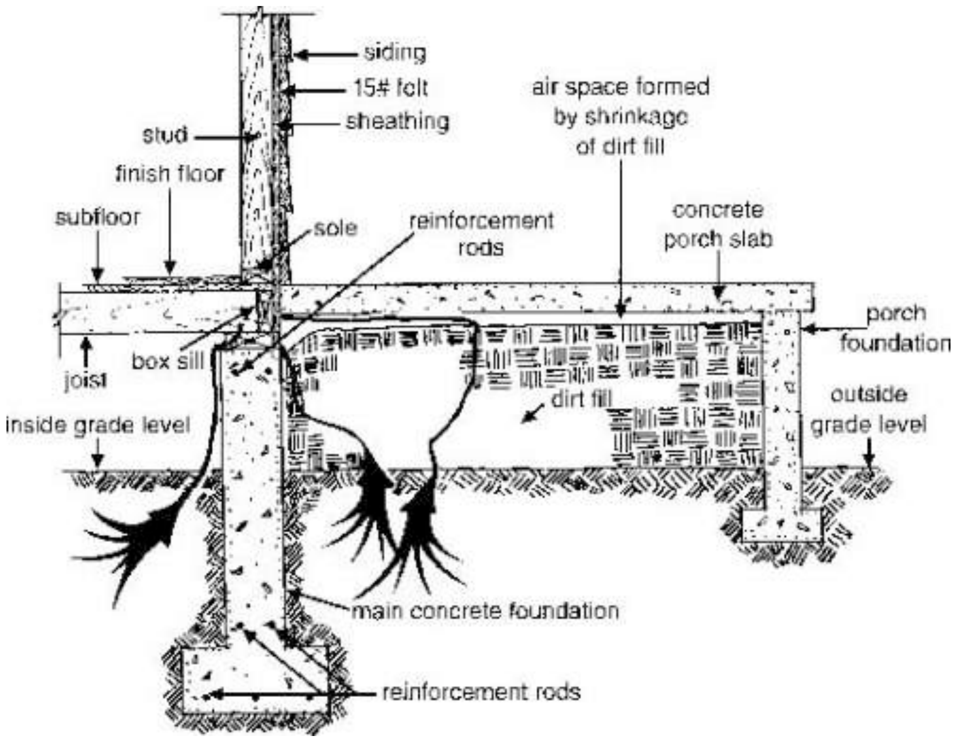


Figure 65. This is a common type of construction that involves a dirt-filled concrete porch attached to a frame house. Avenues of termite access are indicated by the heavy areas in the soil (NPMA).

Soil contact where the porch joins the house should be eliminated by tunneling along the foundation wall and removing the dirt. This is usually done by removing a portion of the porch wall at either or both ends and installing an access door. Soil removal can also be accomplished by knocking out portions of the foundation wall from inside the crawlspace and then excavating soil from beneath the porch.

Where the tunneling leaves the porch poorly supported, it is necessary to install supplementary support, such as masonry piers. The soil along the outside of the foundation wall is then treated at a rate of 4 gallons of chemical per 10 linear feet, and the remainder of the accessible soil under the slab is flooded at the rate of 1 gallon of chemical per 10 square feet.

Some experts recommend that the entire area under the porch be flooded sufficiently to treat all the soil under the porch. Others do not think this is necessary. If all of the soil is treated, termiticide is applied by drilling vertically through the porch slab at intervals along the porch foundation and at other points sufficient to ensure that all the soil under the porch is reached. Foam applications may be of the most value in these situations.

Wooden Porches

Wooden porches with exterior ground contact should have all wood cut off above ground level, with supporting concrete placed under it. Wherever possible, wooden piers should be removed and replaced with concrete, or set on a concrete footing that extends at least 4 inches above grade level. Where this is not possible, the soil should be treated according to the termiticide label's directions. The soil all around the base of the pier should also be treated.

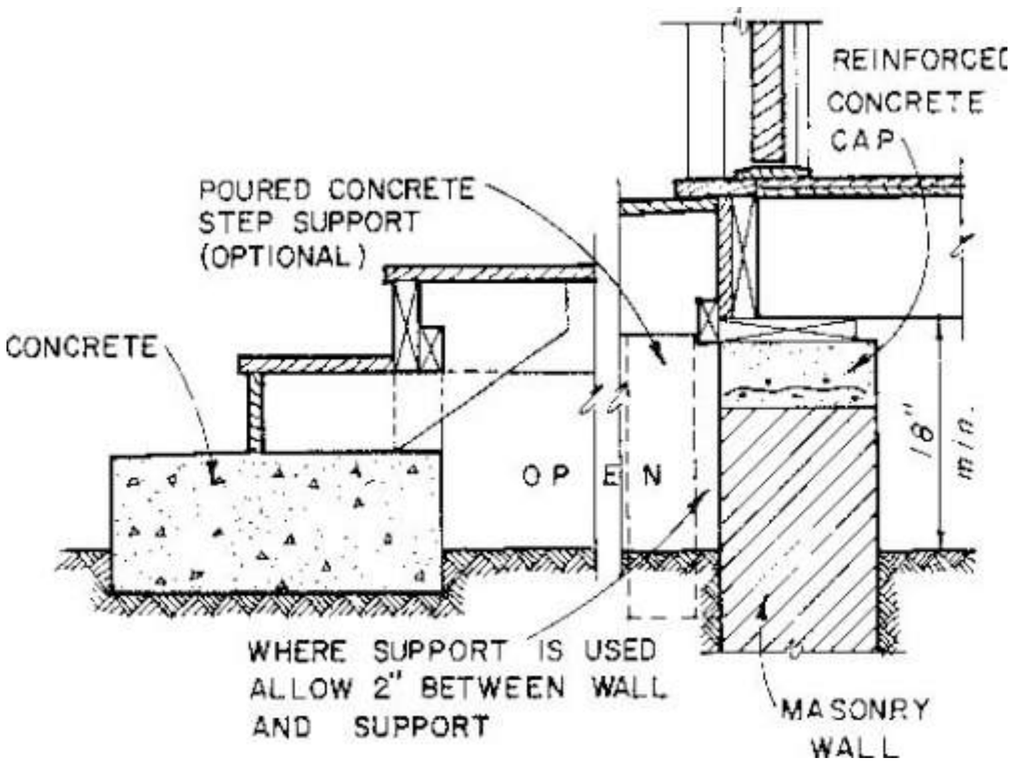


Figure 66. Construction of wooden steps of a porch to prevent hidden termite entry (graphic adapted from USDA)

Hollow-Block, Tile and Rubble Foundations

Sometimes, termiticide will leak through these types of construction materials or vapor will escape from the uncapped tops of hollow blocks, causing residue problems. If this may be a problem, the professional should make sure that all cracks and openings are sealed. If the mortar joints of rubble walls are in poor condition, the wall should be sealed with concrete. Low pressure or gravity should be used whenever treating the voids.

Wells, Cisterns and Other Water Sources

It is the professional's responsibility to apply the termiticide without contaminating the water supply. Special precautions should be taken if wells, cisterns or springs are located near the treatment area. The professional should know the restrictions placed on termiticide application by state or local pesticide regulations regarding the minimum acceptable distance between wells and sources of pollution. The professional must comply with these regulations and label directions for the chemical being used.

The insecticides currently being used move very little once they are deposited on the soil and the emulsion has dried. Movement is usually the result of the emulsion flooding through underground channels, such as those left by old tree roots, through soil that tends to crack severely during periods of drought, or through rock crevices.

Faulty wells are probably the most common cause of contamination. These faults permit surface water to enter the well, usually along the supply pipes that lead into the dwelling. Wells may be constructed in a variety of ways. The casing material is an important factor to consider. Wells may be cased with steel tubing, stone, concrete, or even drainage tiles. Older wells are particularly vulnerable to contamination because the casing may have deteriorated and thus may no longer seal the well from contamination. This is a particular problem with stone-, concrete- and tile-cased wells, which are poorly sealed to begin with.

Because it is difficult for the pest management professional (PMP) to detect defective well construction or a faulty well, s/he should request that the well be tested for coliform bacteria by the local health department prior to administering termite treatment. A positive test indicates that surface runoff is entering the well. This would also indicate that the termiticide may also enter the well, so the application should not be administered.

The well’s location, distance from the structure, depth and location of the supply line must all be recorded during the pre-treatment inspection. It is especially important to ask about the location of water wells and cisterns because the well may be buried and cannot be seen. The inspection should determine runoff patterns, with the slope of the land and the location of paved surfaces noted. This is especially important if the treatment is to take place uphill of the well because most shallow groundwater flows in roughly the same direction as the land slopes. The soil type and permeability, seasonal height of water tables, and depth of foundation footings need to be known.

The permeability of soils and seasonal height of water tables can sometimes be obtained from the U.S. Department of Agriculture's (USDA) soil surveys for individual counties. If there are no published surveys available for a particular site, representatives of the USDA Soil Conservation Service may have detailed site information from mapping work in progress. Local well drillers, drainage contractors and builders are good sources of information for the depth of the local water table. Some important information published in soil surveys includes the permeability of soils to a depth of 5 feet, the soil texture (the amount of gravel, sand, silt and clay typically found in the soil), and the percentage of organic matter found in the soil. Generally, the coarser the soil -- that is, the more sand and gravel found in the soil -- the more permeable it is. Conversely, the more organic matter there is in soil, the more water it will hold.

Treatment Procedures Near the Well and Supply Lines

The soil nearest the well should not be treated by rodding even under reduced pressure. The soil should be trenched along the foundation and the termiticide solution applied at the recommended rates. The termiticides should be mixed with the loose soil while refilling the trench.

An alternative method requires removing the soil from the trench and placing it on a waterproof tarp. The termiticide should be applied to the soil on the tarp and mixed together. The treated backfill is then placed back into the trench. The trench can be lined with polyethylene prior to replacing the treated backfill. The polyethylene lining is another method of preventing movement of the termiticide during application. All treated soil should be covered, according to label directions.

Extreme care is needed when applying a termiticide around the water supply line. The termiticide may follow the pipe and reach the well. The supply pipe should be uncovered from the structure out toward the well for a short distance so that seepage along the pipe can be detected. The treated backfill or the polyethylene lining application technique can be used to apply the termiticide along the foundation near the supply pipe.

Care should be taken that only the amount of chemical needed is applied and is done so slowly enough to let the soil hold it. Soil that is water-saturated or frozen should not be treated. Flooding and runoff should be avoided.

Finally, it may not be possible to solve the customer's problem safely with a termiticide application. It may be necessary for them to consider mechanical alterations to the structure to the extent that it is economically feasible.

It is often difficult to control termites effectively where cisterns or wells are installed without contaminating the water supply. Mechanical alteration, baiting, and direct wood treatment should be relied on as much as possible, even though the cost may be high. If soil treating is done, it should be done only sparingly and carefully.

The soil beneath structures that contain wells, cisterns or springs within the foundation walls should not be treated. Unused wells should be filled, not just capped. The closer a water source is to the foundation, the greater the potential for contamination. In very dry weather, termiticides can move considerable distances along cracks and fissures in the soil. They also can move through small void areas between the soil, pipes and casings.

Swimming pools might be contaminated in the same manner. Sandy soils lessen the potential for these problems.

Extreme care should be used when applying treatment adjacent to walls through which any water lines run. If the well is close to the foundation, the professional should consider not treating that wall (with the written permission and understanding of the customer). When wells are in the vicinity, the PMP should check with the local authorities and comply with any special distance requirements.

A good general practice for treating soil next to foundation walls near wells and cisterns is to remove the soil from the grade to the footing and place it on plastic sheeting. The PMP should treat this soil outside of the foundation and let it dry thoroughly, then return the treated soil to the trench. If the soil around a water pipe is to be treated, that soil should be removed completely from around the pipe and treated as above. The PMP should be sure that the treated backfill is completely dry before placing it in the trench. If the pipe is leaking, treatment should be postponed until the leak is repaired. Alternative treatments to consider when well water contamination is a concern include the use of borate wood treatments and/or termite baiting systems.

RIGID FOAM INSULATION BOARD

When buildings contain foam insulation that comes into direct contact with the soil, it is virtually impossible to eliminate termites with a soil treatment.

Building methods that cause problems include:

- concrete foundations between insulation boards;
- rigid foam insulation board extending below grade level; and
- foam-filled concrete blocks.

Termites do not eat the foam but tunnel through the insulation to get to the wood in the structure. This allows them to avoid contact with soil treatment barriers.

Termite infestation in foam insulation board is not often visible during an inspection. The property owner should remove the exterior foam to 6 inches above and below grade level to allow for proper treatment and future inspection.

In crawlspaces, the insulation should be removed from the interior foundation in the same manner. Control may be achieved by trenching and treating soil and backfilling where the insulation board has been removed to below grade. This will create a soil barrier that interrupts the termites' access through the insulation.

Soil treatments will not prevent termite entry into structures that contain foam-filled, hollow-block foundations because voids cannot be properly treated. Termites can enter through a crack in the footing in this type of construction. The best treatment method for structures with in-ground foam insulation is to use termite baits.

Wood Treatment

Since the advent of soil treatment for termites, there has been little need for extensive wood treatment of structures; however, soil treatment is not possible for all structures, and in such cases the following wood treatment techniques provide some protection from termite attack.

- Borates are applied to wooden structural components in a water-based dilution that is absorbed into the wood fibers. They are applied to prevent termite attack. Because borates are stomach poisons and must be ingested by the termites to be effective, they will not prevent termites from tubing across treated wood to reach untreated portions of the structure. They generally do not have any contact residual effect. Borates are highly soluble in water and can leach out of treated wood. On the positive side, borates are easy to work with and are generally considered low-hazard. The borates will remain effective in the wood indefinitely if the treated wood is kept dry and out of contact with the soil. In addition to termites, the borates give protection against powderpost beetles and wood-destroying fungi.

- Wood injection is performed by using aerosol or liquid emulsion formulations of residual insecticides that can be injected directly into termite galleries where termites are actively feeding in wood portions of a structure. The termiticide will bond with soil particles in the termite galleries as it does in soil to provide some extended residual effect. Treating wood surfaces with contact residual insecticides provides some short-term barrier effect, but will not provide extended protection as does soil application. It may also be possible to inject aerosol insecticides directly into holes drilled in wood, but it is difficult to achieve the complete saturation of all wood fibers in an amount necessary to prevent termite attack. Wood treatment is most commonly used as a supplement to either a soil treatment or termite baiting because of the difficulty in treating all wooden components. Wood treatment can, however, provide limited control where soil cannot be treated because of the risk of groundwater contamination or contamination via the sub-slab heating ducts.

Treatment Odors

The most common complaint about termite treatments is the chemical odor that may linger afterward. Although the chemicals themselves have little odor, the solvents, emulsifiers, impurities and related compounds in the formulation can create odors that will often disturb the customer. Under various conditions, these odors can be strong, offensive and long-lasting -- a situation that leads to many problems, complaints, and even lawsuits.

Clients should be informed that there may be some odors associated with the treatment for three or four days. To prevent odor buildup when treating structures, the structure must be ventilated. Windows and doors should be open, and fans can be used to circulate air. Air conditioners should be turned off, and upstairs doors should be closed, when possible.

Any uncapped masonry voids should be sealed before or immediately after treatment. Aerosol foam insulation, strips of roofing material or tar paper anchored by roofing cement, or solid bricks or caps can be used to seal the voids.

Crawlspaces pose special problems. Vents should be installed if they are not already present. If there is excess moisture or dampness, the treatment should be postponed until the soil dries. If a squeezed clump of soil retains its shape without flaking or falling apart, the soil is probably too wet. Most termiticide labels have stern warnings about treating wet or frozen soil. The excess moisture in treated soil causes odors to linger for several days. Treated soil can be covered with a layer of untreated soil, and vapor barriers can be placed over treated soil. There are also masking and odor-reducing products that can be added to the spray tank.

The PMP should caulk, fill or seal openings through the floor of a crawlspace, such as plumbing, air vents and bath traps. Special care should be taken if there is a furnace or ductwork in the crawlspace. All ductwork must be sealed. Some types of systems may not be treatable without major odor problems. If ductwork is accidentally treated with one of the new termiticides, there are ways of decontaminating the site, but they are very expensive. If the PMP has any concern with a potential odor problem, s/he should seek additional help before treatment, and explain the problem to the customer.

Pumps should be operated at pressures between 25 to 50 psi to minimize splashing. All holes should be plugged after injection, with all visible cracks in basement or masonry walls sealed. It is a good practice for the PMP to have an assistant inside a basement to warn of any seepage problems. Dehumidifiers should be used in basements to remove moisture and speed drying. For extreme odor problems, activated charcoal filters can be placed on ventilating fare or in the furnace and ducts.

Summary

To apply termiticides safely and effectively, the PMP needs to understand and recognize situations where the application of liquid termiticides could lead to contamination of air flow systems and water sources. These situations include plenum crawlspaces, air ducts in non-plenum crawlspaces, sub-slab heating ducts, drains leading into basement sumps, and wells, cisterns and other water sources located on a property. The pest management professional must be trained in methods for preventing termiticide contamination and leaks. In some situations, the use of liquid termiticides may not be possible and the PMP may need to rely on alternative methods, such as termite baits, mechanical alteration and/or wood treatment, for control.

CHAPTER 9: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

The accidental introduction of a termiticide into _______ can result in a serious contamination of the air that flows through them and into living quarters.

- (•) air ducts (correct)
- ( ) drainpipes
- ( ) plumbing fixtures

T/F: Treatment should be reconsidered if it appears that the ducts are made of material containing cellulose, if they have soil or sand bottoms, if they contain standing water, or if they are not properly sealed,

- False
- True (correct)

T/F: French drains in basements can pose a problem for termiticide application.

- True (correct)
- False

One of the most common problems in the control of subterranean termites is a _______ member that extends through the concrete in the basement floor.

- wooden (correct)
- masonry
- steel
- plastic
- concrete

T/F: Soil contact where a porch joins the house should be eliminated by tunneling along the foundation wall and removing the dirt.

- True (correct)
- False

A faulty _____ is probably the most common cause of contamination.

- tower
- sink
- well (correct)
- toilet

When a building contains foam insulation that comes into direct contact wth soil, it is virtually _______ to eliminate termites with a soil treatment.

- impossible (correct)
- instantaneous

CHAPTER 10: APPLICATION EQUIPMENT

APPLICATION EQUIPMENT AND CALIBRATION

After successful completion of this section, you should:

- Know the basic types of equipment used in termite control and how they function.
- Know the various components of power sprayers and how they are used.
- Understand calibration of power sprayers and use of flow meters.
- Know the types of equipment needed.

The proper selection and correct operation of application equipment are essential to the success of any pest control operation. Problems such as non-uniform coverage and failure of a pesticide to reach the target organisms effectively may be solved, in part, through proper selection and operation.

Equipment should be in good condition and heavy-duty enough to get the job done as easily as possible without expensive, time-consuming breakdowns on the job. Spray tanks should be made of durable materials that will not deteriorate when exposed to certain pesticide formulations. Proper maintenance, including regular cleaning and checking of equipment, will help ensure the proper delivery rate and uniform application of chemicals.

Termite Application Equipment

The basic piece of equipment used in any termite job is a sprayer with a tank and pump system used to inject termiticides into the soil, wall voids, and other areas to be treated.

Below is a list of accessories needed, along with the spray system. These tools and their selection are left to the individual specialist or company. As new technologies enter the marketplace, pest management professionals must determine which pieces of equipment best fit the needs of the company.

Sprayer Components

Sprayers used in the termite-control industry are often referred to as large-volume sprayers or power sprayers. There are many variations of these types of sprayers, but the basic components are: tank; pump and motor; hose; applicator; and accessories (strainers, pressure gauge, etc.).

Typical termite control equipment and accessories for one truck:

Spray-Related Equipment:

- 100-gal. tank
- 10-gpm pump
- 3-hp motor
- hose reel
- treating 3/8-in. hose (100 to 200 ft.)
- shutoff valve
- backflow preventer
- hose to refill tank (25 to 50 ft.)
- measuring container
- can of gasoline
- funnel
- kit maintenance tools
- extra hose washers
- extra sparkplug
- spare can of oil

Application-Related Equipment

- electric rotary drill for wall voids
- electric hammer for concrete floors
- bits for drill and hammer
- heat gun for tile
- tile cutter
- extension cord (heavy-duty three-wire type)
- 6-ft. extension rods (for sub-slab treating)
- sub-slab injector, side injector tip, flanged treating tip
- termiticide
- termiticide label
- package of vents for foundations
- mortar or cement mix
- small sledgehammer
- crowbar
- shovel
- trowel

- heavy-duty flashlight
- extra batteries for flashlight
- saw, keyhole
- saw, crosscut
- grounding box
- grounding tester

Personal Protective (PPE) & Safety Equipment

- two pairs of coveralls
- pair of heavy gloves
- pair of light plastic gloves
- safety glasses or goggles
- bump hat (hardhat)
- respirator
- first-aid kit
- cell phone with local Poison Control Center's phone number
- fire extinguisher
- cleanup items:
    - broom
    - dustpan
    - vacuum cleaner
    - rake
    - mop and mop bucket
    - spill cleanup absorbent
    - clean rags

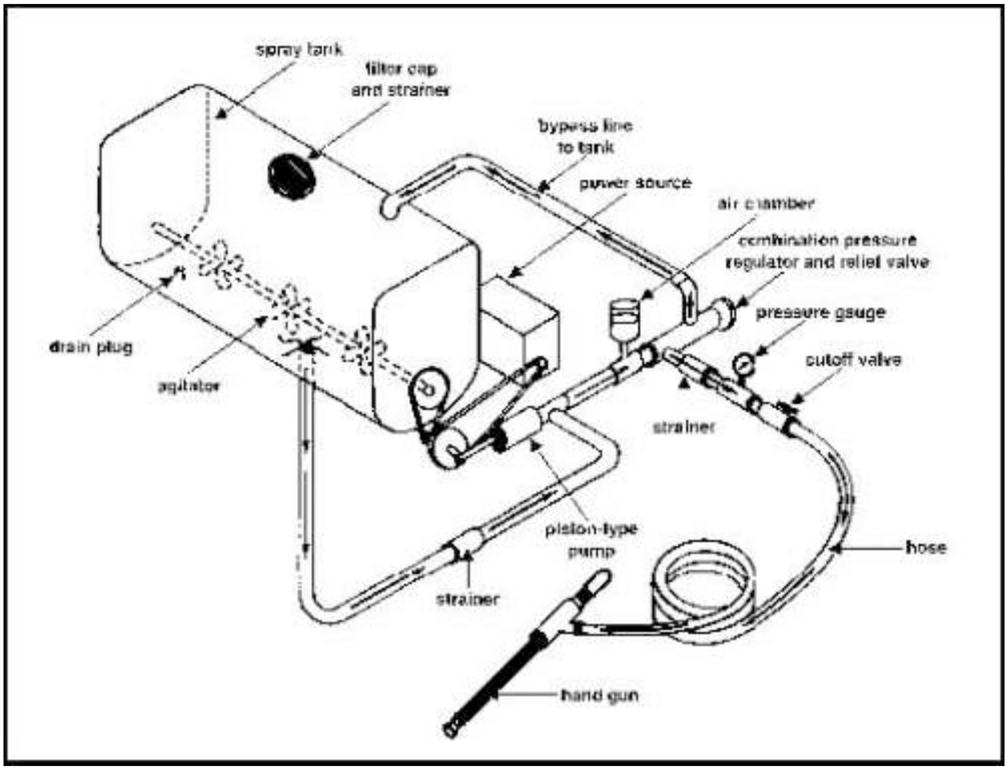


Figure 67. A schematic illustration of a simple power sprayer rig

Tanks

A typical tank used for termite control has a 100-gallon capacity. Some dual systems are set up with two 50-gallon tanks. Most tanks manufactured today are made of fiberglass or polyethylene, which are resistant to the corrosive properties of pesticides. They are usually translucent to allow the applicator to view the level of liquid in the tank. The tank should have large openings for easy filling and cleaning, as well as some provision for straining during filling. Similarly, it should have large drains and other outlets sized to the pump's capacity. If a dual-tank system is used, the plumbing should provide for agitation and adequate withdrawal rates in both tanks. All tanks should have a gauge to show the liquid level. External gauges should be protected to prevent breakage. Most tanks contain a shutoff valve for holding liquid pesticide temporarily while other sprayer parts are being serviced.

Pumps

The pump is used to generate hydraulic pressure (pressure created by fluids) to the pesticide directly in the line, rather than pressurizing the tank. The liquid is entrapped and pushed out of the line rapidly. There are many types of pumps that vary in size and capabilities.

Gasoline or electric motors ranging in power from 3/4 to 7 horsepower are used to drive the pumps. The three types of pumps most commonly used in pest management operations are roller, piston and diaphragm.

Roller pumps are among the least expensive and most widely used pumps in the industry. They pump moderate volumes of liquid, 8 to 30 gallons per minute (gpm), at low to moderate pressure (10 to 300 psi). Roller pumps are available equipped with five to eight rollers. The more rollers the pump has, the more power the pump has. The smaller roller pump models are often used for termite control because they produce the desired low pressure, they are economical, and they are easily repaired. The recommended operating pressure for termite operations is between 25 and 50 psi at the nozzle.

Piston pumps are the most durable of the various power pumps; they are also more expensive than other types. They deliver low to medium volume (2 to 25 gpm) at low to high pressure (20 to 600 psi). Piston pumps are used for high-pressure sprayers or when both low and high pressures are needed. The smaller models, such as the twin-piston pump, are commonly used in termite-control operations.

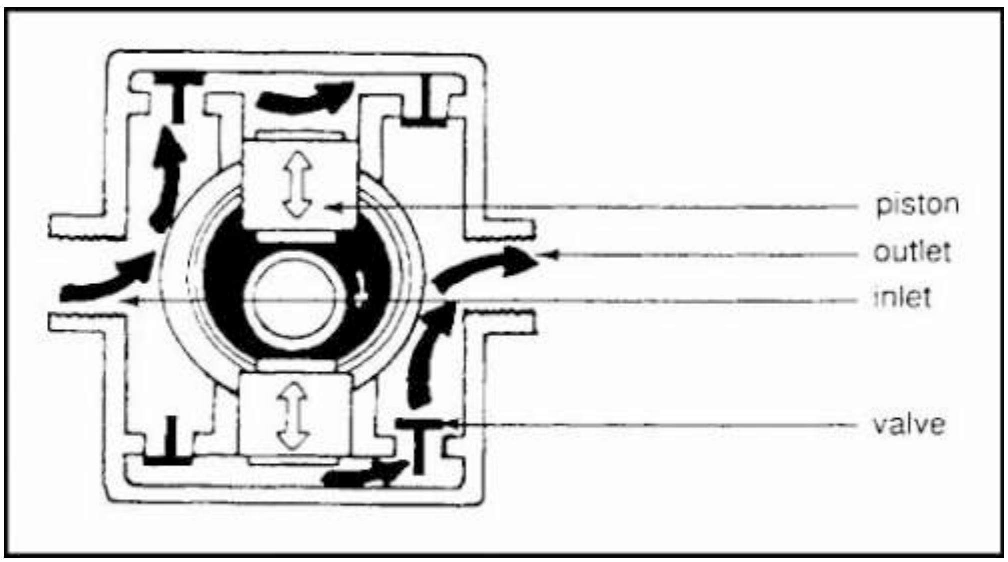


Figure 68. Piston pump

Piston pump cylinders are made of materials such as iron and stainless steel, or they may be lined with porcelain. The pump casing is typically made of iron. The piston cups are replaceable and are made of leather, neoprene or nylon fabric. These materials make the pump abrasion-resistant and capable of handling various types of pesticides, including wettable powders. However, when piston pumps fail, they tend to do so rapidly. Therefore, it is wise to carry a spare pump on the truck. Piston pumps also create a pulsating or throbbing action that can be damaging to gauges, valves, hose fittings and other parts. When pulsation is a problem, it is necessary to have a surge tank in the line to reduce the force of the pulsation. A surge tank is a small chamber containing air. It is placed in the discharge line between the pump and the control valve and serves to cushion the peak of the pulses produced by the pump so that a more even and regular flow is available at the nozzle.

Diaphragm pumps are used when most of the work involves only low-volume, low-pressure applications because diaphragm pumps deliver a low volume (1.4 to 10 gpm) at low to moderate pressure (10 to 100 psi). They withstand abrasion from wettable-powder mixtures much better than roller pumps because the spray mixture does not contact any moving parts except the valves. Some solvents may damage the rubber or neoprene diaphragm. The small diaphragm pumps are often used with new portable systems in treating crawlspaces and attics.

Hoses

The hose of a large-volume sprayer is a vital part of the system. The hose must be long enough for the purpose intended, wide enough to carry an adequate flow of liquid, and made of materials that will not be deteriorated by the pesticides.

It is important to use only a high-quality hose and to maintain the hose in good condition. Cheap or worn hoses may suddenly burst on the job, and pesticides may spill or splash onto people or property and contaminate the environment. Dual-power sprayer hoses are usually made of polyvinyl chloride (PVC) and are capable of withstanding working pressures of up to 600 psi or more. PVC hoses are more lightweight than rubber hoses but tend to stiffen in cool weather.

Hoses used in termite operations usually have an inside diameter of 3/8- to 1/2-inch. When choosing hose size, it is important to remember that the smallest opening in the spray line determines the actual capacity of delivery, regardless of the size of the hose. Thus, if a hose with a 1/2-inch inside diameter is used with couplings that have an inside diameter of 1/4-inch, the delivery rate of the hose will be that of a 1/4-inch hose. Therefore, it is important to match hoses and couplings properly to deliver the desired volume of spray.

Finally, hose length is also an important consideration. Most professionals use between 150 and 300 feet of hose, which provides extra length when it is needed. Hose reels, operated by hand cranks or by an electric rewind motor, enable the professional to handle and manage long lengths of hose.

Applicators

Figure 69. Pest management professional applying termiticide to the soil by long rodding the exterior of a house

At the end of the hose, various types of applicators with valves are used to apply termiticide. These include rods, sub-slab injectors, and guns. Rods 3 to 6 feet long can be used to apply termiticide into the soil next to the foundation wall. Carious small rods are used to inject insecticide into the voids of walls and through concrete slabs.

Sub-slab injectors are used to force termiticide into holes through concrete slabs to the fill underneath. This device is essential because it seals the hole around the application rod; considerable back-pressure is frequently encountered during the process, making it difficult to inject a sufficient quantity of chemical. A tapered rubber stopper around the applicator rod can also be used. It is frequently necessary to drill holes through masonry construction. Small holes can be drilled with carbide-tipped rotary bits in an ordinary electric hand drill.
Application tools are continually being developed and improved. Better soil-injection equipment, especially injection tips and flow meters, is being produced for more practical for termite control. More versatile foam-application equipment is now available.

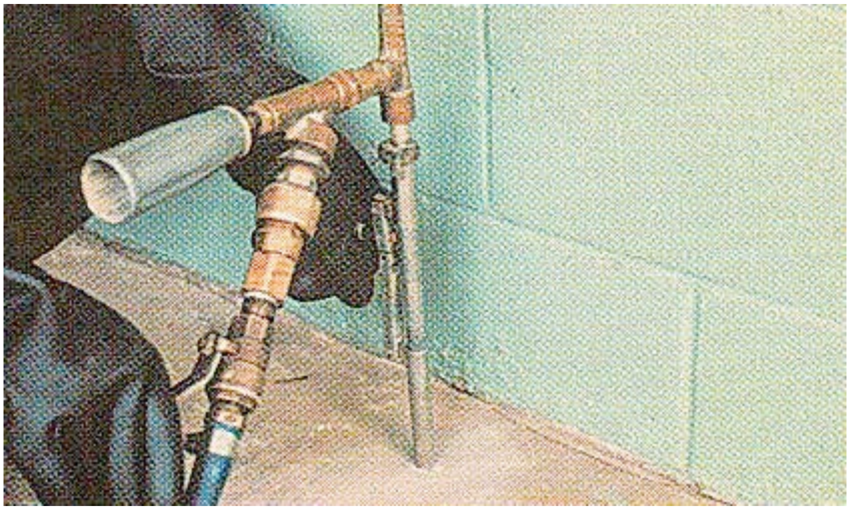


Figure 70. A slab injector is used to inject termiticide under pressure into an area beneath a slab.

Drills

Various-sized drills and rotary hammers are used to facilitate application of termiticide by drilling holes through concrete. Large holes are drilled using electric or compressed air hammers. As a general rule, rotary hammers drill faster than the non-rotary types because dust is removed from the hole mechanically as it is drilled. Carbide-tipped drill bits are more expensive than steel drills but cut faster and require much less sharpening.

Air hammers have the advantage of rapid drilling speed even with large-diameter drills, and the hammer itself is usually relatively lightweight, making work less tiring for the pest management professional. Electric hammers of comparable specifications are usually heavier and drill slower than air hammers. Because they do not require the use of a heavy air compressor, they are more portable than air hammers and create less dust.

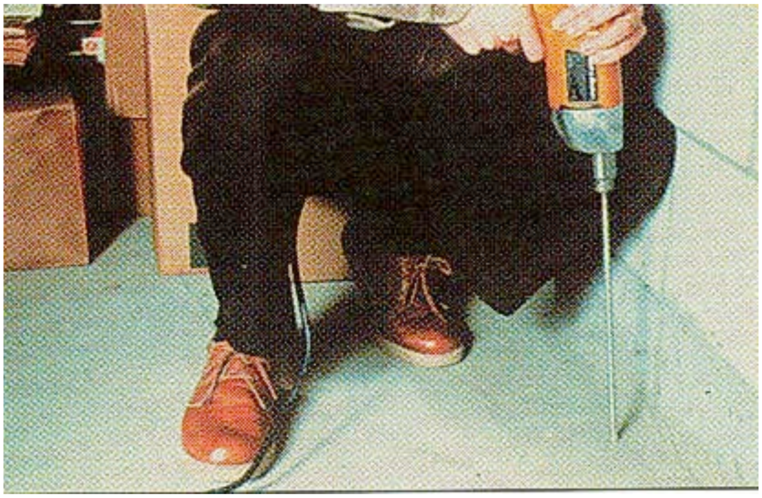


Figure 71. Slabs are drilled so that termiticide can be injected through holes to treat the soil beneath.

Calibration of Sprayers

Calibration is the process of measuring and adjusting the amount of pesticide the equipment will apply to a specific area. In structural pest management, the judgment of the pest control operator is key. A pest management professional should know whether the proper concentration of pesticide is being applied. Without accurate calibration of the sprayers, the amount of pesticide delivered will be incorrect. Concentrations that exceed the label's directions will contaminate the spray area or result in runoff. Less than the recommended dosage might fail to control the pest. Technicians need to look regularly at the output of their equipment. Flow meters are very helpful for determining the output of the sprayer over time.

Application rates may be determined by use of a flow meter (water meter), timer, or by using the "slow-count" method. In the timer or slow-count method, a 1-gallon container is filled with water and the delivery rate is determined on a timed basis.

The application rate or delivery rate is generally measured as the amount of time it takes to deliver 1 gallon of liquid per unit area. Delivery rates vary considerably in termite control operations and depend on several factors, such as the type of soil the termiticides are being injected into (the composition, compaction, etc.), the method used to inject the insecticide, and the type of construction being treated.

Equipment may need to be calibrated for each specialized situation. Flow meters are preferred for this because they provide the operator with a constant and accurate reading of the delivery rate.

The rate should be checked when applying large quantities of solution to make sure that the timing or count is accurate. Injecting chemicals into soil results in lower delivery rates per unit of time because of back-pressure. Differences in soil composition and compaction also affect delivery rate. In most instances, a flow meter is preferred because it provides the operator with a constant and accurate reading of the delivery rate.
Sample calibration problems are given in the following slides.

CHAPTER 10: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

T/F: Problems such as non-uniform coverage and failure of a pesticide to reach the target organisms effectively may be solved, in part, through proper selection and operation of equipment.

- (•) True (correct)
- ( ) False

The basic piece of equipment used in any termite job is a _______ with a tank and ______ system used to inject termiticides into the soil, wall voids, and other areas to be treated.

- ( ) shovel..... spray
- ( ) wand..... bottle
- ( ) hose..... trenching
- ( ) bowl..... GPS
- (•) sprayer..... pump (correct)

The typical tank used for termite control has a ____-gallon capacity.

- ( ) 10
- ( ) 20
- ( ) 200
- (•) 100 (correct)

T/F: The pump is used to generate hydraulic pressure (the pressure created by fluids) to the pesticide directly in the line, rather than pressurizing the tank.

- True (correct)
- False

Low-quality or worn ______ may suddenly burst on the job, and pesticides may spill or splash onto people or property and contaminate the environment.

- nozzles
- clamps
- pumps
- hoses (correct)

Without accurate _________ of the sprayer, the amount of pesticide delivered will be incorrect, and concentrations exceeding label's directions will contaminate the spray area or result in runoff.

- cleaning
- maintenance
- recording
- testing
- calibration (correct)

CHAPTER 11: CONTAMINATION OF DRINKING WATER

PREVENTING CONTAMINATION OF DRINKING WATER

Liquids can be drawn into water pipes by siphoning action or back-pressure. Accidental contamination of entire residential districts has occurred when the drinking water line had a sudden drop in pressure while a sprayer or tank of termiticide was being filled with water from a hose connected to a residence's faucet. The drop in water pressure siphoned the termiticide into the public water supply system.

The basic precautions to aid in avoiding this kind of mishap include:

1. Never permit a water hose or faucet to extend into the insecticide or the rinse water while filling a spray tank or rinsing the insecticide application equipment.

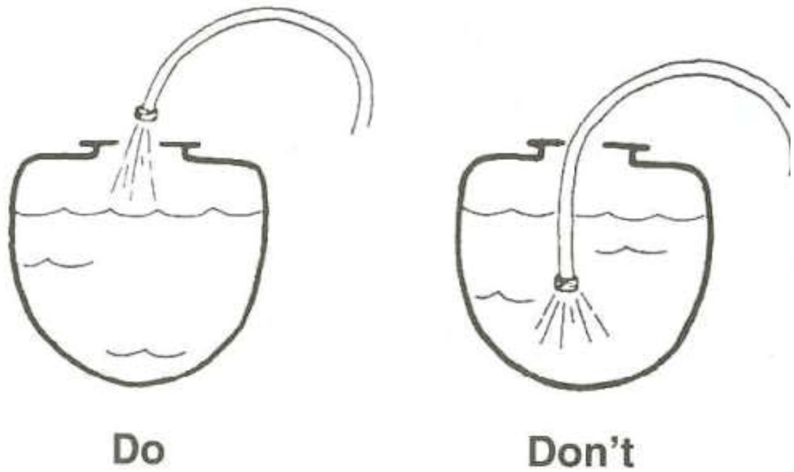


Figure 72. Keep hoses out of contaminated water.

2. Back-flow preventers should be used to prevent the contamination of water supplies. A back-flow preventer should be installed on the end of the hose connected to the faucet any time water is being used from private or public systems to fill pesticide tanks or equipment. It must be located between the water source and the pesticide tanks. Back-flow preventers vary substantially in the level of protection offered, so selection is important.

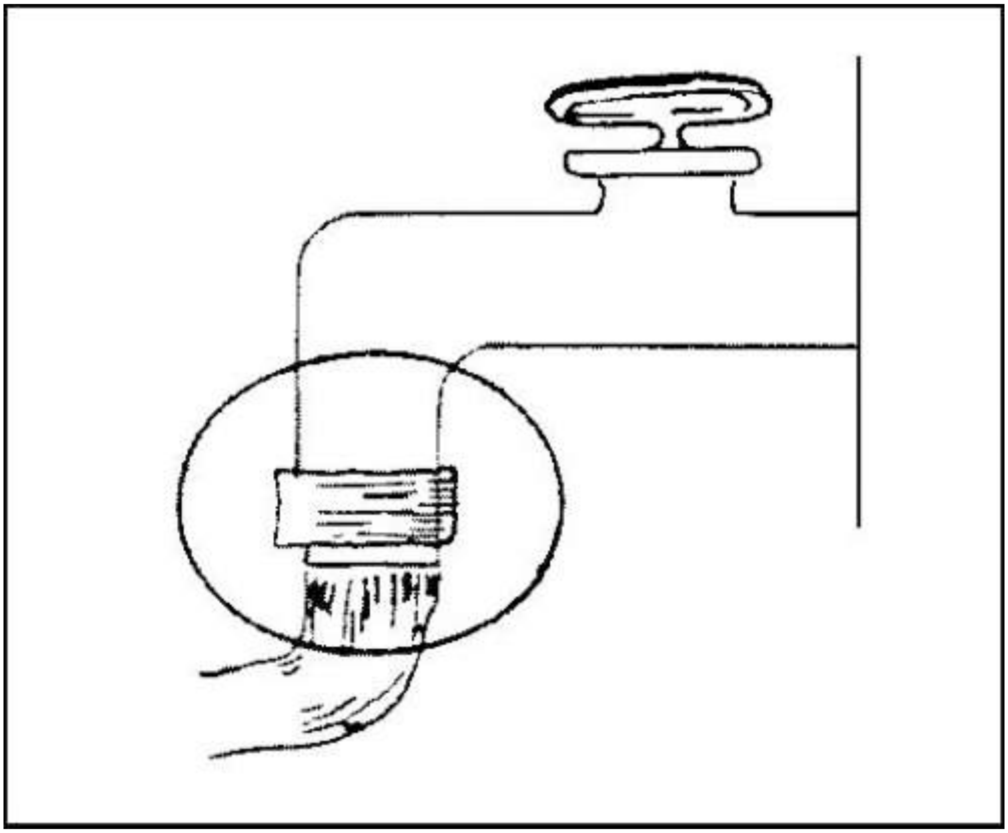


Figure 73. A back-flow preventer should be installed on the end of the hose connected to the faucet. This helps prevent accidental contact of contaminated water in the spray tank with the building's water supply.

The picture above shows a back-flow preventer in the open and closed positions. When the water is turned off, the valve closes and prevents back-flow or back-siphonage. If back-flow occurs through the hose, the liquid exits through the atmospheric ports.

Back-flow preventers for hose connection installations should meet the American Society of Sanitary Engineers (ASSE) Standard 1011 (Hose Connection Vacuum Breakers.)

Back-flow preventers for hose connections meeting ASSE Standard 1011 are not designed to prevent back-flow if the back-pressure greatly exceeds that of the water system, such as might occur if the hose is connected to the discharge side of a pump. These devices might prevent such back-flow for a short period of time, but they must not be relied on for this protection. They do protect from back-siphonage or low back-flow pressure such as might occur if a hose accidentally gets into a spray tank and the tank is above the water system.

Continuous-pressure, in-line back-flow preventers meeting ASSE Standard 1012 will prevent back-flow even if the back-pressure is high. However, they are designed for permanent installations. Some newer homes have back-flow preventers built into their exterior spigots.

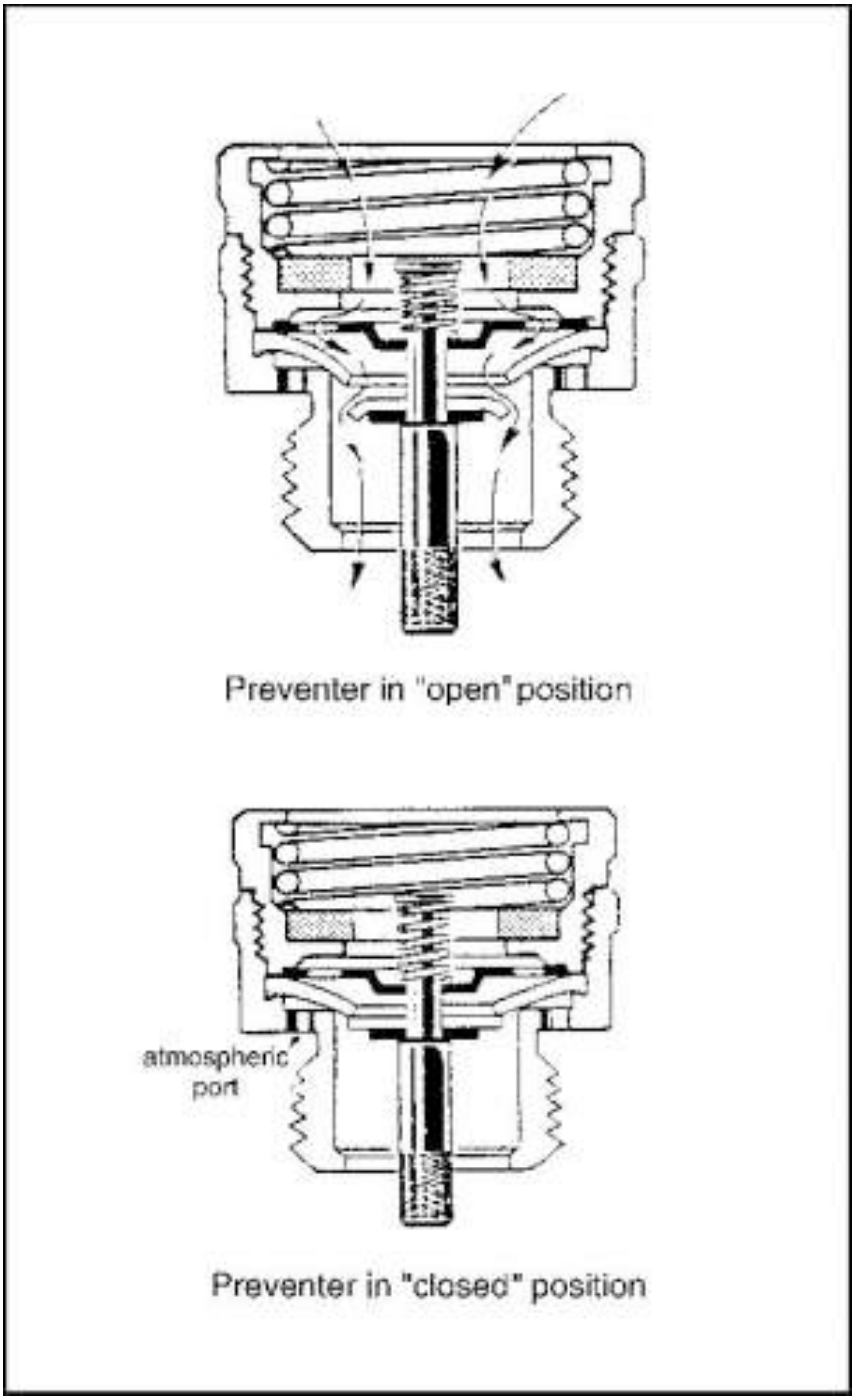


Figure 74. Backflow preventer in open and closed positions

Back-flow preventers can be obtained from some pest control suppliers or from plumping supply houses. Advice on local codes and requirements can be obtained from plumbing or health inspectors.

In the event of water contamination, the city, county or state health officials should be contacted immediately.

Inspection of Wells

Many termiticide labels refer to application near wells. Labels of termiticides contain statements that warn against “contamination of public and private water supplies.” The necessity of preventing any termiticide or other pesticide from reaching water supplies must be clearly understood by those making inspections and recommendations. It is also essential for the technicians performing the application to understand the importance of their work around the structure.

If a well is present on a property, it is important for the inspector to be aware of several problems that could lead to introduction of termiticide into the water supply:

1. Faulty wells are the most common cause of pesticide contamination reported to the National Pest Management Association (NPMA). Faults in the sealing of the well permit surface water to enter the well, usually along the pipes leading to the building. This type of well is also susceptible to biological (bacterial) contamination.

2. Old cisterns or dug wells that are no longer in use but have not been properly filled are susceptible to contamination from termite applications. Chemicals can accumulate in them and seep into wells or cisterns in use, or into the groundwater.

3. Cisterns or wells within the structure can become contaminated. Adequate inspection should reveal this potential problem.

   Note: Many termiticide labels have specific instructions on treatment of structures that contain wells or cisterns.

4. Unusual fill problems or a change in the surface grade may permit liquid chemical to move by concealed routes into the well.

5. Tree roots often reach water sources. These may also be direct channels for termiticides to follow, especially after the tree or root decays, dies, and leaves an open channel through the soil.

6. A high water table can result in the contamination of a well after a termiticide application.

In most of these situations, adequate inspection can uncover a potential problem. The pest management professional must be extremely careful and use expert judgment when performing control procedures. In cases where chemicals have been introduced into wells, even after removal procedures, health departments have sometimes ordered new wells to be drilled. The cost to the pest management professional can be great in increased insurance premiums, time spent in removal procedures and tests, and loss of customers because of adverse publicity.

Inspection is the first and most important step in designing a safe treatment procedure.

The owner should be questioned about:

- the well's location from the foundation;
- the depth of the well;
- where the supply line enters the structure; and
- the depth to the water.

After obtaining this information, its accuracy should be checked by observation.

If the homeowner intends to hook up to a public water supply, the termite treatment should be delayed until after that occurs.

The inspector should note any factors that may influence the decision of the type of method to use or feasibility of performing treatment. The common problems listed previously are of particular importance.

Also, note particularly:

- the slope of the land or paved surfaces around the house;
- the run-off patterns;
- the type of soil and its moisture level; and
- the depth of foundation footings.

CHAPTER 12: SAMPLE CALIBRATION PROBLEMS

1. Compute solutions as a percentage of weight.

$$\text{lbs. of pesticide to use} = \frac{\text{\% by weight desired x gal. final product x 8.34}}{\text{\% of original product}}$$

EXAMPLE:
How much wettable powder pesticide containing 40% active ingredient should be added to a 100-gallon tank if recommended treatment is 0.25% concentrate by weight?

$$\text{lbs. of pesticide to use} = \frac{\text{0.0025 x 100 gallon x 8.34}}{\text{0.40}} = \text{5.2 lbs. pesticide needed}$$

2. Compute ppm in solution from mixing wettable powder.

$$\text{lbs. of pesticide to use} = \frac{\text{ppm desired x gal. final product x 8.34}}{\text{1,000,000 x \% of original product}}$$

EXAMPLE:
How much wettable powder pesticide containing 40% active ingredient should be added to a 100-gallon tank if recommended treatment is 1,200-ppm a.i.?

$$\text{lbs. of pesticide to use} = \frac{\text{1,200 x 100 gallon x 8.34}}{\text{1,000,000 x 0.40}} = \text{5.2 lbs. pesticide needed}$$

3. Compute ppm mixing emulsifiable concentrate.

$$\text{Gallons of pesticide to use} = \frac{\text{ppm desired x gal. final product x 8.34}}{\text{1,000,000 x \% of original product}}$$

EXAMPLE:
How much liquid emulsifiable concentrate containing 0.625 lbs. active ingredient (a.i./gallon) should be added to a 100-gallon tank if recommended treatment is 300-ppm a.i. of a liquid pesticide?

$$\text{Gallons of pesticide to use} = \frac{300 \times 100 \text{ gallon} \times 8.34}{1{,}000{,}000 \times 0.625} = 0.4 \text{ gallon pesticide needed}$$

4. Compute percentage of desired concentration when using an emulsifiable concentrate. (The gallons of EC needed to mix a spray containing a given percentage of active ingredient.)

$$\text{Gallons of pesticide to use} = \frac{\text{gallon desired} \times \% \text{ a.i.} \times 8.34}{\text{lbs. a.i./gallon} \times 100}$$

EXAMPLE: How much 25% EC (2 lbs./gal.) pesticide is needed to make 50 gallons of a 0.25% finished spray?

$$\text{Gallons of pesticide to use} = \frac{50 \times 0.25 \times 8.34}{2 \times 100} = 0.52 \text{ lbs pesticide needed}$$

5. Compute percentage of concentration when ppm is known.

$$\% \text{ Concentration} = \frac{\text{ppm}}{10{,}000}$$

EXAMPLE: What is the percentage of a solution with 1,000 ppm?

$$\% \text{ Concentration} = \frac{1{,}000}{10{,}000} = 0.1\%$$

6. Compute ppm of a solution when the percentage is known.

$$\text{PPM} = \% \times 10{,}000$$

EXAMPLE: How many ppm of a pesticide is there in a 2% solution?

PPM = 2 x 10,000 = 20,000 ppm

7. Compute dilution of a concentration of known percentage to the desired percentage.

Desired amount of final product x concentration of final product

Amount of concentrated pesticide to use = --

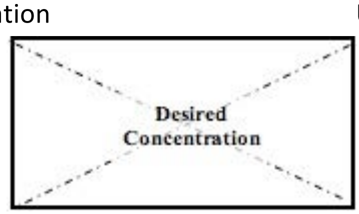
Concentration of original product

EXAMPLE: How much 40% dust pesticide is needed to mix 5 lbs. of a 25% powder?

$$\text{Amount of pesticide to use} = \frac{5 \times 25}{40} = 3.125 \text{ lbs. pesticide and } 1.875 \text{ lbs. of filler needed}$$

8. Compute dilution to a desired concentration by using the Dairyman's Rectangle.

Known concentration Unknown concentration

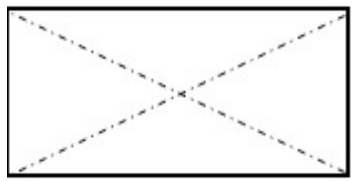


Known concentration Unknown concentration

(subtract along dotted lines)

EXAMPLE: Make a 70% solution from a 95% solution.

95 70 parts 95 % solution



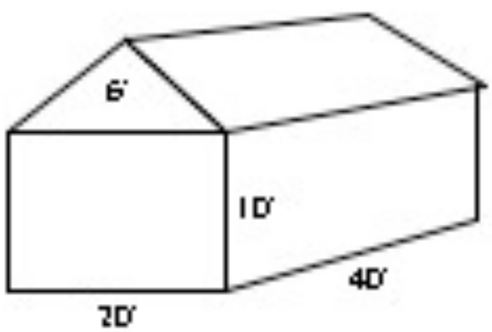
0 25 parts water

9. Compute the area (cube) to be fogged or space to be treated.

a. Area is a parallelogram:
Cube = length x width x height
Example: 40 feet long by 20 feet wide by 10 feet high
Cube = 40 x 20 x 10 = 8,000 cubic feet

b. Area with a pitched ceiling:

$$\text{Cube} = \text{length} \times \text{width} \times \text{wall height} + \frac{\text{Pitch height} \times \text{width} \times \text{length}}{2}$$



Example:
Length = 40 feet
Width = 20 feet
Wall height = 10 feet
Pitch height = 6 feet

$$\text{Cube} = 40 \times 20 \times 10 + \frac{6 \times 20 \times 40}{2} = 10{,}400 \text{ cubic feet}$$

2

CHAPTER 13: OTHER WOOD-DESTROYING INSECTS

After successfully completing this section, you should:

- Know what to advise lumber and construction companies and consumers on what they can do to prevent wood-boring beetle infestations.
- Know the various families of wood-boring beetles and their characteristics.
- Know the different inspection, management and control methods for wood-boring beetle infestations.
- Know which long-horned beetle is a structural pest, how to identify it and control it, and how to its prevent structural damage.
- Know the signs of carpenter ant infestation and what areas to inspect for excess moisture.
- Know the habits and habitats of carpenter ants and where to inspect for their nest locations.
- Know the procedures for preventing and controlling carpenter ant infestations.
- Know how to identify carpenter bees and understand their habits and habitat.
- Know the procedures for preventing and controlling carpenter bee damage to wood.

Wood-destroying organisms other than subterranean termites cause millions of dollars in damage to wood products each year. These organisms and their prevention and control are discussed here.

Figure 75. Old house borer beetle

Prevention of Wood-Boring Beetles

The wood-boring beetles of economic concern include powderpost beetles, false powderpost beetles, furniture and deathwatch beetles, and the old house borer. Most of the procedures that will prevent their attacks on wood are the responsibility of those who harvest, mill and/or store the wood. Those who use wood must take precautions to reduce the chance of building an infestation into structures and furniture.

Though the pest management professional is usually called in after an infestation is suspected, it is important that this person be a knowledgeable consultant for the lumber and construction industries, as well as to consumers, on the prevention of damage caused by wood-boring beetles.

Here are some steps that can be taken to prevent beetles from infesting buildings.

- Inspect wood prior to purchase.
- Use properly kiln- or air-dried wood.
- Seal all wood surfaces.
- Use chemically treated wood.
- Ensure that good building designs are used.

Using kiln- or air-dried wood in construction is one of the least expensive and most practical preventive measures. A few beetle species can survive and re-infest wood that has been properly dried. Sealing wood surfaces with varnish, shellac or paint eliminates the habitat necessary for egg laying, but it is usually not feasible to seal the surfaces of structural timbers. Using chemically treated wood (treated by fumigation, wood preservatives or insecticides) will provide that wood remains beetle-free, but using treated wood is usually cost-prohibitive. In addition, fumigation will not protect the wood from future infestation.

Using good building design and practices, including proper ventilation, drainage and clearance between the wood and soil will tend to reduce the moisture content of wood in a structure, creating less favorable conditions for beetle development. Central heating and cooling systems also speed up the wood's drying process.

There are numerous species of wood-boring insects that show up in houses. If not controlled quickly, some of these can cause considerable damage. Other pests are of minor importance and attack only unseasoned wood. Beetles and wasps all have larval or grub stages in their life cycles, and the mature flying insects produce entry and exit holes in the surface of the wood. These holes, and sawdust from the tunnels they create behind the holes, are generally the first evidence of an attack that's visible to the building inspector.

Correct identification of the insect responsible for damage is essential if the appropriate control method is to be selected. The characteristics of each of the more common groups of beetles and wasps are discussed in the following table which summarizes the size and shape of entry and exit holes produced by wood-boring insects, the types of wood they attack, the appearance of frass (sawdust) in insect tunnels, and the insect's ability to re-infest wood in a house.

To use the table, match the size and shape of the exit/entry holes in the wood to those described in the table; note whether the damaged wood is a hardwood or softwood, and whether the damage is in a new or old wood product (evidence of inactive infestations of insects that attack only new wood will often be found in old wood; there is no need for control of these). Next, probe the wood to determine the appearance of the frass. It should then be possible to identify the insect type. It is clear from the table that there is often considerable variation within particular insect groups. Where the inspector is unsure of the identity of the insect causing damage, a qualified entomologist should be consulted.

Powderpost Beetles

"Powderpost beetle" is a term used to describe several species of wood-boring insects. Powderpost beetles damage wood slowly; thus, homeowners should not feel as though they must act immediately in order to preserve the structural integrity of their home. A "wait and see" approach is often desirable, especially when there is doubt as to whether the infestation is currently active.

Most powderpost beetles are introduced into homes in lumber or finished wood products, such as furniture and flooring. Lumber that has been improperly dried or stored should not be used, particularly if beetle exit holes are present. Many of the most serious infestations arise from old lumber from a barn or old woodpile that is repurposed to panel a room or build an addition.

Powderpost beetles will only lay their eggs on bare, unfinished wood. Wood that is painted, varnished, waxed or similarly sealed is generally safe from attack, provided no unfinished surfaces are exposed. Bare wood can be protected from attack by painting or finishing exposed surfaces. Beetles emerging from finished articles, such as furniture, were probably in the wood before the finish was applied. However, note that beetles emerging from finished wood can re-infest the wood by laying eggs in their own exit holes. Sealing the holes prevents this possibility.

Powderpost beetles can be found in dead as well as dried and cured lumber. Damage can occur to many wooden components in a home, such as the rafters, joists, flooring, moldings and paneling, as well as crating, furniture, antiques, tool handles, gunstocks, fishing poles and baskets. Homeowners are much more likely to see the damage caused by these beetles than the beetles themselves. Sometimes, homeowners may hear rasping or ticking in the wood at night, notice a blistering appearance on the wood, see powdery frass piles below holes in the wood, or find numerous round or oval exit holes at the wood's surface. They may even see powderpost beetles collect around windows or lights.

Figure 76. Beetle infestation and damage

Mistakes are sometimes made determining if the infestation is active or non-active. Infestations sometimes die out of their own accord. Therefore, it is important to be able to determine whether the infestation is active or inactive. Active infestation will usually be evidenced by powder the color of fresh-cut wood sifting from the exit holes. In contrast to old, abandoned holes, new holes will not have taken on the weathered appearance of the surrounding wood. Powder or frass streaming from recently opened holes may accumulate in small piles beneath the exit holes. If these piles of powder are covered with a film of dust or debris, the damage is old. Careful observation may be required to distinguish new powder from frass that has been dislodged from old larval galleries by vibration.

One means of confirming that an infestation is active is to mark or seal any existing exit holes. The homeowner can use a crayon or tape over the holes to see if more holes appear. Then the powder should be swept up, and the wood should be re-checked for new holes and powder at a later date. Since most emergence occurs from April to July, it might be worthwhile to wait until the following spring to determine if new holes and fresh powder are present. This is especially useful when attempting to make a determination during the fall or winter months.

Moisture

Powderpost beetles, especially anobiids, have specific moisture requirements for survival. Since wood moisture levels below 13% during spring and summer)are generally unsuitable for anobiid development or re-infestation, it's advisable to install a moisture barrier in the crawlspace of infested buildings. Covering the soil with 4- to 6-mil polyethylene reduces movement of moisture into the substructure and reduces the threat of an infestation spreading upward into walls and the upper portions (wooden components) of the building.

Most beetles do not develop in wood with a moisture content below 10 to 15%. Another way to lower moisture content in damp crawlspaces is to increase ventilation. This can be accomplished by installing foundation vents at 1 square foot of vent area per 150 square feet of crawlspace. Moisture meters used by some pest-control operators are useful tools for predicting the potential re-infestation in wood.

Kiln-Dried Lumber

For new construction, kiln-dried lumber should be used. This lumber should have been dried a minimum of eight hours at 130° F to 140° F and at 80% relative humidity. Also, wood preserved using chromated copper arsenate (CCA) salts (described as Wolmanized®) is an excellent choice for wood that will come into contact with soil. The life of CCA-treated wood is 40 years or more. This product is not available directly to consumers to apply to wood around their homes because pressure application is essential. Treated wood has a slightly green cast and is often sold for use as landscape timbers and for fencing and deck construction. Compounds available under the trade name of Cuprinol™ are sold directly to consumers. However, its penetration on wood surfaces is only about 1/8-inch, and its protection is much briefer than that of CCA-treated wood.

Some wood-boring beetles complete their life cycle in a few months, while others live in wood for 30 years before emerging.

Lyctid Powderpost Beetles

Lyctids attack only the sapwood of hardwoods with large pores, such as oak, hickory, ash, walnut, pecan, and many tropical hardwoods. They re-infest seasoned wood until it disintegrates. They attack seasoned hardwood and sapwood timbers found in woodwork molding, window and door frames, plywood, flooring, structural wood, furniture, tool handles and firewood. A few species attack softwoods, but pine and soft woods are not normally attacked. Lyctids rarely attack and re-infest seasoned wood or wood that is older than five years. Infestations usually result from wood that contained eggs or larvae when placed in the home. The wood could have been improperly dried or stored. Larvae cause the damage.

Lyctids range from 1/32- to 1/16-inch in length. They are flattened, slender, and reddish-brown to black. The basal abdominal segment is long, and the antennae bear a cub of only two segments. The head is visible from above. Mature larvae are C-shaped, slightly hairy, with three pairs of spine-like legs, and yellowish-white with a brown head.

The presence of small piles of fine flour-like or talc-like wood powder (frass) on or under the wood is the most obvious sign of infestation. The frass could be loosely packed in tunnels. Even a slight jarring of the wood makes the frass sift from the holes. Large quantities of frass often fall out at exit holes and cracks. There are no fecal pellets. The exit holes are round and vary from 1/32- to 1/16-inch in diameter. Most of the tunnels are about 1/16-inch in diameter and loosely packed with fine frass. If damage is severe, within a few years the sapwood may be completely converted to frass that is held in by a very thin veneer of surface wood with beetle exit holes. The amount of damage depends on the level of starch in the wood. The length of the life cycle for lyctids is three months to one year.

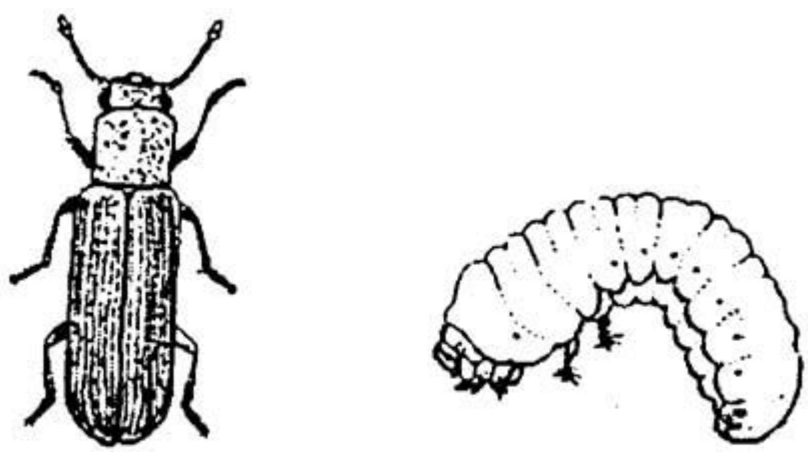


Figure 77. Lyctid powderpost beetle adult and larva

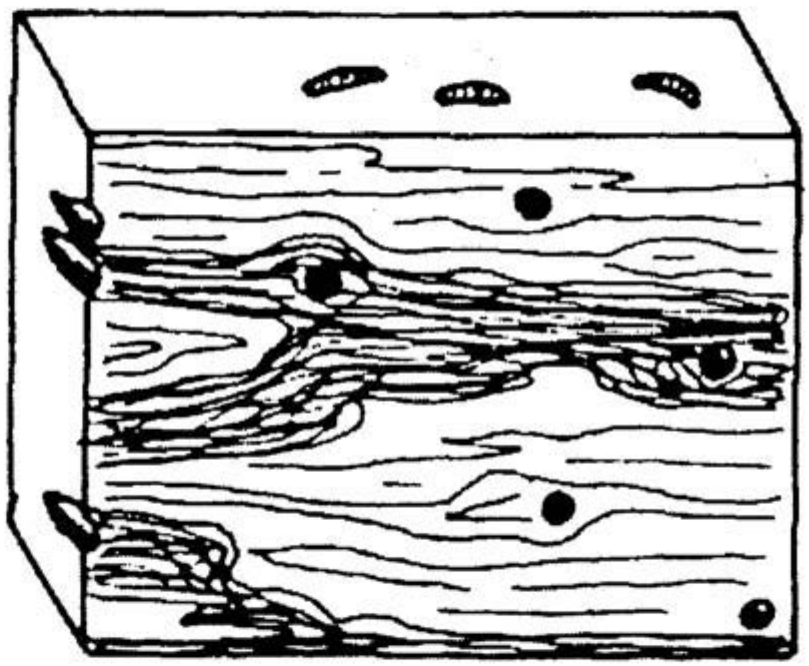


Figure 78. Typical powderpost beetle damage

Infestations are normally limited to hardwood paneling, trim, furniture and flooring. Replacement or removal and fumigation of infested materials are usually the most economical and effective control methods. For current information on the use of residual insecticides, the inspector should contact the entomologist at his nearest land-grant university or a reputable pest control company.

Anobiid Beetles

The most common anobiids attack the sapwood of hardwoods and softwoods. They re-infest seasoned wood if environmental conditions are favorable. Attacks often start in poorly heated or ventilated crawlspaces and spread to other parts of the house. They rarely occur in houses on slab foundations. Anobiids prefer to infest wood that is damp; therefore, infestation usually begins in moist, poorly ventilated areas, such as crawlspaces, basements, garages and utility sheds. Under favorable conditions of moisture and temperature, infestations may occur as the result of using infested lumber, from beetles flying in from outdoors, or from beetles living in firewood that is carried indoors.

Infestations develop slowly, but wood can be re-infested year after year.

Anobiids are called "deathwatch beetles" because, in the past, superstitious people believed that the ticking sound that one species makes foretold an impending death in the household. Adult beetles make the sound during the mating season by tapping their heads on a hard surface.

Adult anobiids have slender, cylindrical bodies that range from 1/16- to 1/4-inch in length, and are reddish-brown to nearly black. The head is bent downward. The widest point of the thorax is slightly forward of the base, tapering backward and appearing as a rough, diamond-shaped outline. Larvae are C-shaped and nearly white except for a dark head. The length of the life cycle for anobiids is one year to three years. Adult insects are rarely seen. Anobiids typically leave a small amount of frass around their exit holes. The most obvious sign of infestation is the accumulation of powdery frass and tiny pellets underneath infested wood or streaming from exit holes. The exit holes are round and vary from 1/16- to 1/8-inch in diameter. Lyctid frass is extremely fine and feels like talc when rubbed between the fingers. Anobiid frass is also powder-like but feels gritty.

A way to differentiate holes made by lyctids from those created by anobiids is to insert a click-type or retractable ballpoint pen into the exit hole; only the tip of the ball will fit through a lyctid emergence hole. If the hole was made by an anobiid, the tip of the pen will enter part way up the angled face of the point because anobiid holes are slightly larger than lyctid holes.

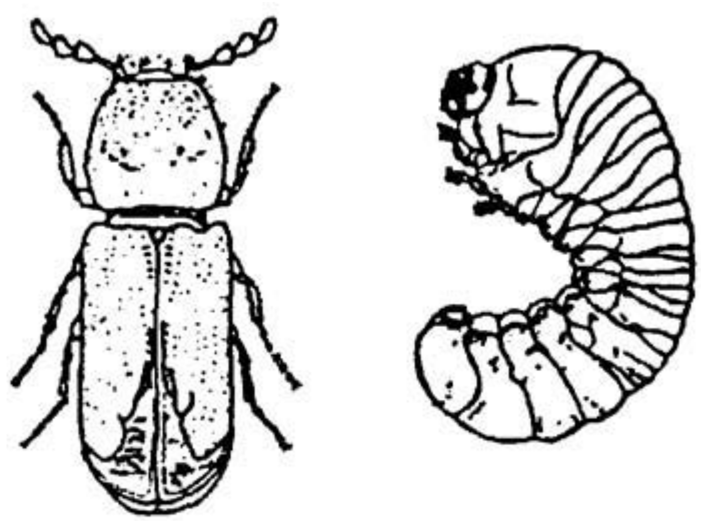


Figure 78. Furniture beetle adult and larva

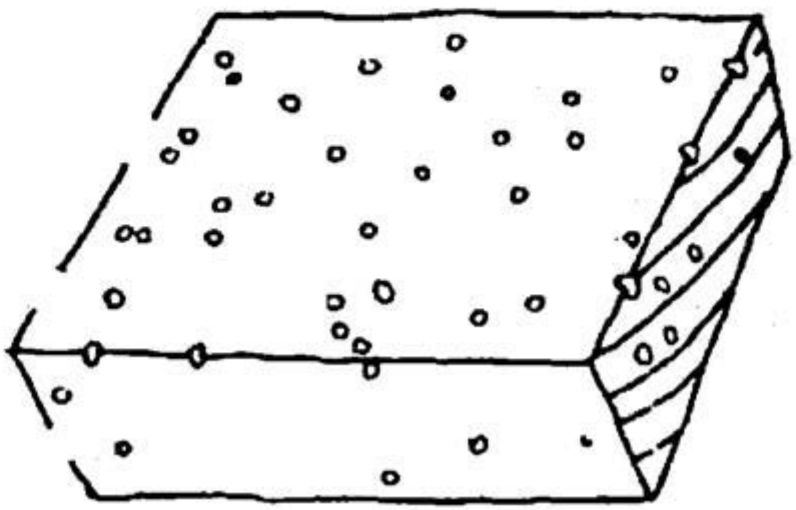


Figure 79. Furniture beetle exit holes

If there are large numbers of holes and the powder is bright and light-colored, similar in appearance to freshly sawed wood, the infestation is both old and active. If all the frass is yellowed and partially caked on the surface where it lies, the infestation has been controlled or has dried out naturally. Anobiid tunnels are normally loosely packed with frass and pellets. It may take 10 years or more before the number of beetles infesting wood becomes large enough for their presence to be noted. Control can be achieved by both chemical and non-chemical methods. For current information on the control of anobiids, the inspector should contact the entomologist at his nearest land-grant university or a reputable pest control company.

Bostrichid Powderpost Beetles

Bostrichids are more abundant in the tropics. Bostrichids range from 1/32- to 3/8-inch in length, and their coloring is reddish-brown to black. Most species have a cylindrical shape. Their thorax is roughened. The antennae bear a club of three distinct segments. The head is usually not visible when viewed from above. Larvae are C-shaped; the body segments immediately behind the head capsule are much wider than the body segments at the rear.

The first signs of infestation are circular entry holes made by the females for their egg tunnels. The exit holes made by other adults are similar but are usually filled with frass. The frass is fine to coarse and contains no pellets. It is tightly packed in the tunnels and does not sift out of the wood easily. The frass tends to stick together.

The exit holes are round and vary from 3/32- to 9/32-inch in diameter. Bostrichid tunnels are round and range from 1/16- to 3/8-inch in diameter. If damage is extreme, the sapwood may be completely consumed. Bostrichids rarely cause significant damage in framing lumber. They primarily affect individual pieces of hardwood flooring and trim. Replacement of structurally weakened members is usually the most economical and effective control method.

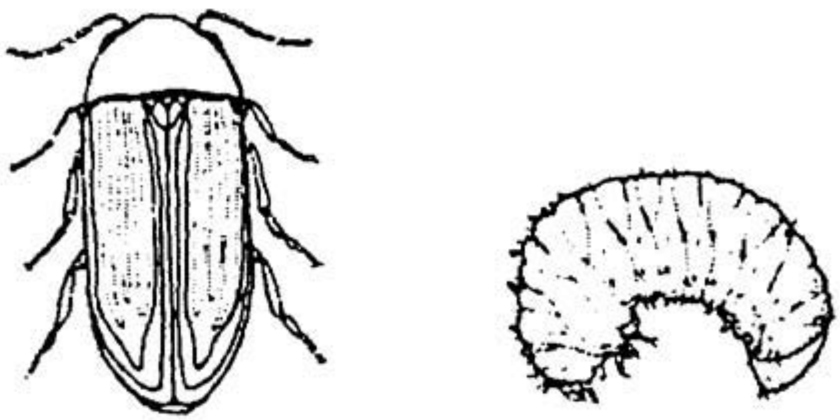


Figure 80. False powderpost beetle the adult and larva

CARPENTER ANTS

The carpenter ant belongs to the genus *Camponotus*. This pest is found widely in the United States and is one of the largest of our common ants. Carpenter ants are so-named because they excavate galleries in wood to create nest sites. They use their strong jaws or mandibles to remove wood as they enlarge the size of their nests. Unlike termites, carpenter ants do not consume wood.

Figure 81. Carpenter ant

The adults vary in length from 1/4-inch for small workers to 3/4-inch for a queen. Carpenter ants are the largest ants in the United States. Size alone is not a good diagnostic tool for an inspector because carpenter ants from a single colony are polymorphic or of different sizes. Polymorphic workers are sometimes called minor, intermediate and major workers (from smallest to largest, respectively).

The body may be black, red, brown, tan, yellow or some combination thereof, depending on the species. They are typically dark brown to black in color. In some states, such as Arkansas, some species are both red and black.

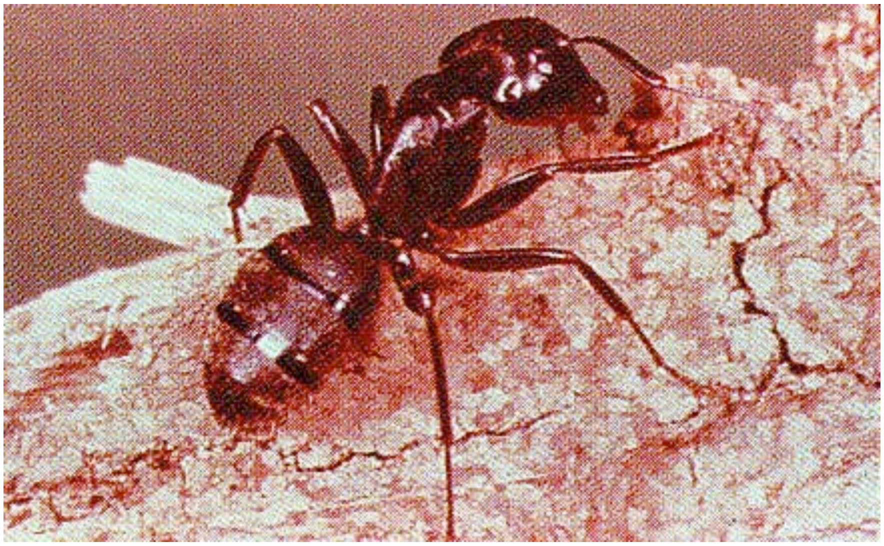


Figure 82. Carpenter ant

Workers have strong mandibles and can bite if they are handled. In addition to delivering a painful bite, they can also inject formic acid into the bite area. Ants do not have a stinger.

Identification

Like other ants, carpenter ants have a constricted waist and elbowed antennae. The alates (winged reproductives) have transparent wings that are not easily removed; the paired forewings are much larger than the hind wings. Winged males are much smaller than the winged females.

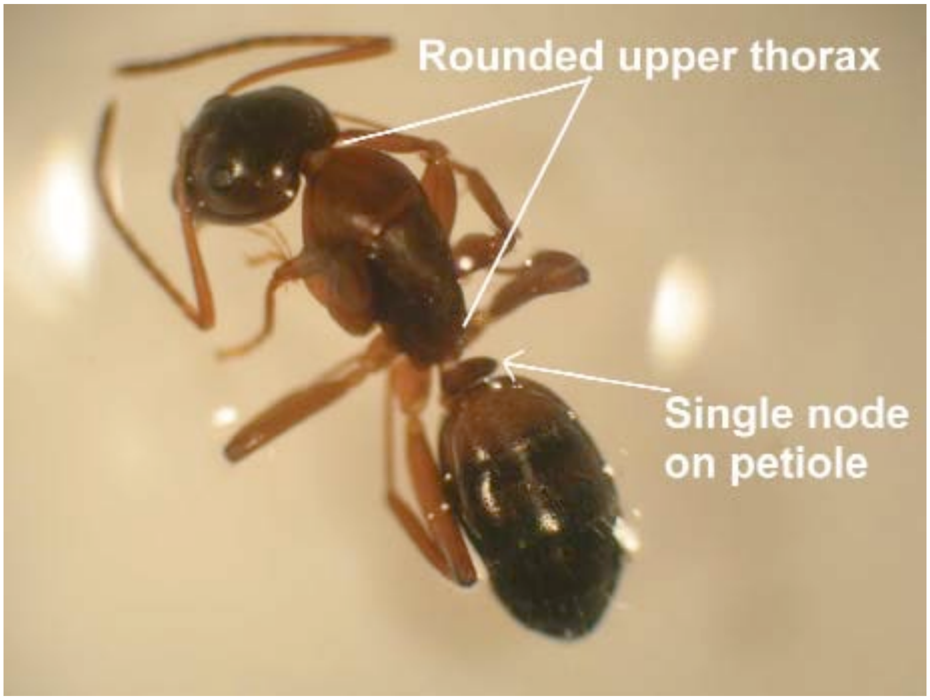


Figure 83. Carpenter ant thorax and node

Carpenters ants have an evenly rounded, arched thorax that can be identified when viewed from the side, one node between the thorax and the abdomen (gaster), and some hair around the anal opening at the tip of the abdomen. The combination of the first two characteristics is useful to distinguish carpenter ants from other ant species.

Carpenter ants do not create mounds in the soil, although Formica ants behave in such manner. Do not report Formica ants.

Black Carpenter Ant Life Cycle

Black carpenter ants are quite common, so it's useful to review the life cycle of a black carpenter ant, which may not pertain to other species of carpenter ants. Winged male and female carpenter ants (swarmers) emerge from mature colonies usually from March to July. After mating, the males die and each newly fertilized female establishes a new colony in a small cavity in some wood, under bark, in a stump or tree section, etc. The first brood of larvae is fed entirely by the queen. She does not take food, but metabolizes stored fat reserves and wing muscles for nourishment. The few workers emerging from the first brood assume the duties of colony maintenance, such as collecting food (the carpenter ant diet consists of a wide range of plant and animal materials), excavating galleries to enlarge the nest, and tending the eggs, larvae and pupae of the second generation. The workers regurgitate food to nourish the queen and the larvae that are developing. The queen has few duties except to lay eggs. All of the workers in the colony are sterile females.

In later generations, workers of various sizes are produced. Larger major workers typically guard the nest, battle intruders, and forage for food; generally, smaller minor workers expand the nest and care for the young. The larvae and pupae must be fed and tended or they die. Larvae are legless and grub-like, later pupating in tough silken, tan-colored cocoons that are sometimes are erroneously referred to as "ant eggs."

A mature colony typically contains approximately 2,000 to 4,000 individuals and produces winged males and females every year.

Black Carpenter Ant Habits

Carpenter ants often establish a number of interconnected nests; the parent nest houses the queen and small larvae, and the satellite nests contain larger larvae and pupae. The parent nest of the black carpenter ant is typically established in a cavity of hardwoods but sometimes in softwoods. The nest is associated with wood that has a moisture content greater than 15% that is often the result of rain, leaks and/or condensation in structures. The satellite nests are usually located in drier areas with higher temperatures that enhance larval and pupal development. The workers can move the brood among the satellite nests. There may be several satellite nests in different locations in or around a structure.

Carpenter ant nests can be found outside or inside a building. They have been found in water-damaged wood around skylights, in chimneys, rain gutters, window and door frames, and wood shingles, as well as inside hollow porch posts and columns, window boxes, crawlspaces, and damp attic spaces, and even inside dishwashers. Sometimes, nests are found in dry areas, such as hollow veneer doors, curtain rods, small voids between the door casing and ceiling, false beams, and under insulation in attics and crawlspaces.

An active colony may produce a distinct, dry rustling or crinkling sound. Sounds of their chewing activity in wood are often loud enough to hear. The worker ants may respond to a disturbance by striking their mandibles and abdomen against the gallery walls so as to warn other colony members. Carpenter ants are most active at night. Large numbers of foragers emerge very soon after sunset to search for food. Foraging ants bring food back to the nest to feed the larvae. Carpenter ants are omnivorous, and they feed on a great variety of both plant and animal materials, including insects (living and dead), plant juices, fresh fruits, honey, jelly, sugar, syrup, meats, grease and fat.

Carbohydrates are the primary energy source for adults (or workers). One of their most common, readily available foods is honeydew, which is a sugary substance excreted by aphids and scale insects feeding on plants. Landscape plants infested with these plant-sucking insects are a good place to inspect for carpenter ants. Carpenter are particularly fond of sweets.

Workers may search for food as far as 100 feet away from their nests. Ants may be found outdoors traveling from a tree cavity or stump to the building. They may travel over tree branches or vines touching the roof, electrical and phone wires, fences next to the house, piles of firewood, logs, or debris. They may be seen walking on plants, tree trunks and rotten wood stumps.
They frequently travel along well-established trails between nest sites and feeding sites.

Carpenter ants seek soft, moist wood in which to establish their nests; they preer wood that has weathered and has begun to decay. Although the nest is most often built in the soft wood, later excavations frequently are made into perfectly sound, dry lumber. Carpenter ants can be found in porch columns and roofs, windowsills, hollow-core doors, wood scraps in dirt-filled slab porches, and wood that's in contact with soil.

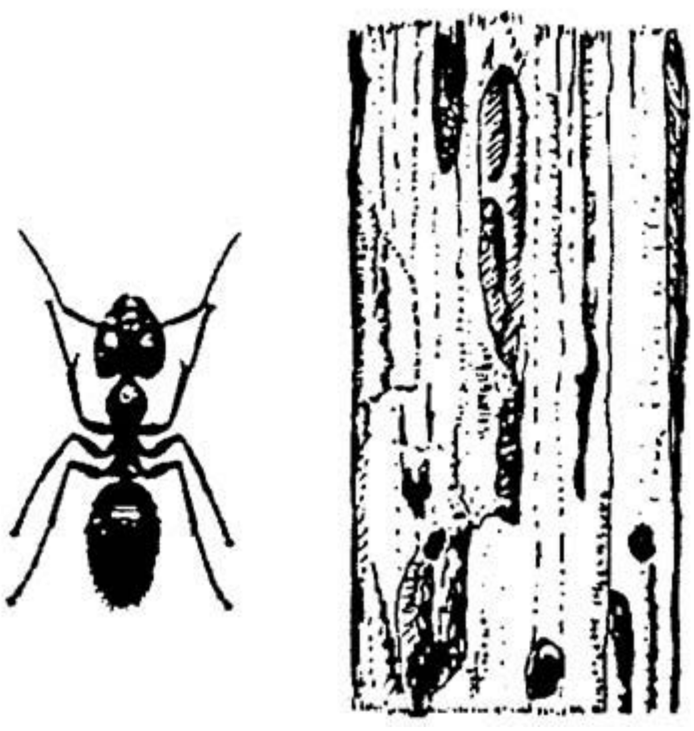


Figure 84. Carpenter ant damage to wood

Characteristics of Damaged Wood

Carpenter ants chew wood with and across the grain, creating irregular, clean galleries. The walls of the galleries are very smooth and sculpted, with a sand-papered appearance. There is no soil found in ant galleries as is found in those made by subterranean termites.

An infestation in a building may be started by a single fertilized female. However, it is often started by a colony or portion of a colony moving in from another location. This is especially true in wooded areas. The queen sheds her wings when the new colony is started and remains wingless the rest of her life. The males are winged and die soon after the mating flight is over. Winged forms are usually not produced in a colony until it is at least three years old. If not controlled, a large colony can cause serious structural damage.

Figure 85. Carpenter ant sawdust pile

Carpenter ants do not eat wood (in contrast with termites), but they do excavate galleries in the wood in which to rear their young. Carpenter ants eject the wood in the form of coarse sawdust. The characteristic sawdust piles aid in nest location. The borings made by carpenter ants consist of wood shavings that resemble those made by a pencil sharpener. The ants carry the wood shavings from the nest and deposit them outside; piles of shavings may be found beneath special openings (windows) or nest openings. The wood shavings often contain portions of insects, empty seed husks, and remnants of other food items.

When carpenter ants are found within a structure, the colony is either nesting within the building or nesting outside the building and entering to forage for food. Houses near wooded areas are especially subject to invasion. Carpenter ants are usually found near moisture.

The key to controlling carpenter ants is to locate their nests, which is often difficult. If the nests can be found, there is an excellent chance of controlling this pest. Eliminating nests outside may be just as important as eliminating those inside buildings. In some cases, an entire colony may migrate from one nesting site to another, such as from a tree outdoors to a home's structural timber indoors.

To find nests indoors, examine these locations:

- wood affected by water seepage, such as porch floors, roofs, porch posts and columns;
- wood in contact with soil;
- wood adjacent to dirt-filled slab porches; and
- firewood piled in a garage or next to the house.

Some signs to look for when inspecting for a carpenter ant nest indoors are:

- piles of coarse sawdust on the floor or foundation; and
- ant activity, particularly in kitchens. However, even when the nest is inside a building, very few ants may be seen.

Carpenter ants are usually active at night and often forage outside.

Some of the things to check outdoors include:

- firewood, stumps, logs and trees that might contain nests;
- trees with branches hanging over and touching the roof of a house. Ants may travel over these branches into the building; and
- power and utility lines leading to the house, particularly if they pass through trees and shrubs.

Sanitation measures, such as removing and destroying logs and stumps that harbor nests, will help eliminate the pest. To protect structures from carpenter ants, destroy the nests in and near the structure.

Control and Management of Carpenter Ants

It is important to discover whether carpenter ants are nesting inside or outside. If nesting inside:

- Their presence usually indicates a moisture problem in the building.
- They may have excavated galleries for harborage in structural wood.

Black carpenter ants are often associated with moisture problems. In the majority of cases, carpenter ants make their nests in wood that has been wet and infested by a brown rot fungus. Dark fungus stains on the wood indicate the presence of such moisture.

Moisture in wood can be caused by:

- improper attachment of wooden additions, dormers or hollow wooden columns that absorb moisture;
- patios or porch floors, door sills, downspouts, or grading where water collects or drains toward the structure;
- repeated gutter overflow that pours rainwater down the side of the building, as well as back onto roof boards, fascia, soffits, etc.;
- leaking roof valleys;
- improper flashing around chimneys, vents and skylights;
- improper roofing practices;
- holes in the roof;
- window sills directly exposed to rain; and/or
- lack of ventilation in any area where moisture accumulates.

Indoors, moisture can accumulate:

- around any leaking plumbing or drains (especially shower drains);
- unvented attics and crawlspaces; and
- unvented or improperly dishwashers, washing machines, icemakers, etc.;

These many potential nesting sites, foraging entrances, and food and moisture sources offer clues for inspection and location of a nest. The area where the majority of ant activity is seen may identify a nest site if entry from the outside can be ruled out. Carpenter ants are more active at night, and inspection during that time may be helpful.

Habitat Modification

Here are some recommendations that inspectors can make to homeowners, some of which may require the assistance of a professional.

- Where nests are located inside, remove and replace infested structural wood.
- Stop the intrusion of moisture.
- Caulk and screen both actual and potential ant entryways.
- Ventilate areas where moisture accumulates, regrade where necessary, and repair roofing and guttering, etc.

- Trim trees where branches touch a structure or overhang roofs. The appropriate utility should be notified if tree branches are in contact with overhead phone or utility cables, as removing the branches can be dangerous or even fatal if not done properly. Tree removal may be necessary.

Pesticide Application

Inspectors and homeowners should be aware of the following:

- Eliminating colonies and nesting sites is a primary way to eliminate carpenter ant infestation.
- Use pesticidal dust or pressurized, canned aerosols for nests that are in wall voids. Sprays are less effective.
- When indirect treatment is required, appropriate bait stations can be placed liberally in areas of suspected activity.
- Dust, spray or bait can be used on outside colonies, such as in a rotting tree stump or in a pile of tree limbs. Professionals should evaluate live trees with rotted areas.
- Honeydew-producing insects involved in feeding carpenter ants should be treated with pesticides (e.g., oils and pesticidal soaps) that will not harm or eliminate useful parasites and predators.

Follow-Up

Carpenter ant infestations often cannot be controlled in just one visit. Thorough re-inspection is needed to make sure that ongoing pest management is effective.

Insecticides should be applied to the nest and surrounding areas. Spraying or dusting the infested area without locating and treating the nest is not recommended because it usually does not provide complete control.

CARPENTER BEES

Carpenter bees, *Xylocopa,* are large, heavy-bodied insects, typically 3/4- to 1-inch long. Their blue-black metallic bodies usually have some yellow or orange hair on the thorax. The upper side of the abdomen is shiny, black and hairless. The female has a black head, and the male has white markings on its head. Carpenter bees have a dense area of hairs on their hind legs. They resemble bumblebees but can be distinguished by their abdomens. The abdomen of the bumblebee is, by contrast, yellow and hairy. Bumblebees also have large pollen baskets on their hind legs.

Carpenter bees do not consume wood, but they excavate galleries in wood and made nests inside. They are basically a nuisance pest, but sometimes they cause damage to wood over time.

Carpenter bees are beneficial insects because they are important pollinators of flowers and trees.

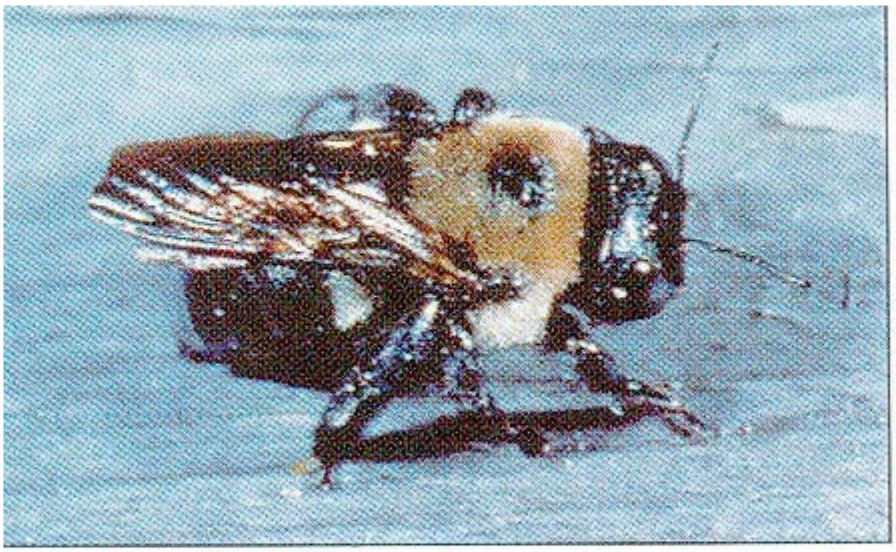


Figure 86. Carpenter bee

In the spring, carpenter bees become a nuisance as they fly close to homes and other buildings. Males hover like hummingbirds, waiting for females to emerge so they can mate. If the males are disturbed, they may hover or buzz around a person's head. Only the females have stingers and can sting, but usually only if disturbed. The males are harmless because they lack a stinger. The bees are noisy. After the mating season, most of their summer is spent loitering around the nest or nearby flowers.

Carpenter bees are a nuisance to have around as they also bore into seasoned wood, especially softwoods such as cedar, redwood, pine and fir. Female bees bore circular holes about 1/2-inch wide into the wood at right angles to the surface to a depth of about an inch. Then they turn sharply, boring in the direction of the wood grain for another 4 to 6 inches.

Structural damage caused by one or two carpenter bees is slight. However, tunnels may be used again and lengthened by other broods. The activity of numerous bees over a period of years is certain to cause some structural damage.

Life Cycle

Carpenter bees are solitary insects that do not form colonies; they are not social, unlike the carpenter ant. The males do not live long. The female carpenter bee prepares the nest during springtime. The female uses her strong mandibles to excavate a clean-cut, round nest entrance hole that is approximately 1/2-inch wide, which is about the diameter of her body. She then excavates a tunnel or gallery that continues inward from the entrance hole for 1 to 2 inches, then turns sharply at a 90-degree angle and runs in the same direction as the wood grain for 4 to 6 inches. She excavates the gallery at the rate of about 1 inch in six days.

The female then places a mixture of pollen and regurgitated nectar ("bee bread") at the far end of an excavated gallery, forms this larval food into a ball, and lays an egg on top of the mass. The ball serves as food for the larvae when the eggs hatch. She then walls off the cell with a plug of chewed wood pulp. Each female may have six to ten partitioned brood cells in a linear row in one gallery. Larvae feed on the pollen/nectar food mass, which is sufficient for them to develop into the adult stage. The life cycle (egg, larva, pupa, adult) is completed in approximately seven weeks. The gallery where the larvae develop is typically concealed within the wood.

The new adult bees chew through the cell partitions and emerge around late August. They collect and store pollen in the existing galleries and then return to the tunnels to hibernate. They will not mate to start the cycle over again until the following spring. In April and early May, they will emerge and mate. The previous year's adults die. There is one generation alive per year.

Habits

Typical indicators of carpenter bee activity in wood are the round entrance holes in the wood, the coarse sawdust from their borings, and deposits of excrement and pollen on surfaces below their entrance holes. The deposits leave unsightly stains. The entrance hole is sometimes not in an exposed, visible area.

Painted wood is rarely attacked by carpenter bees, all exposed wood surfaces should be painted and maintained. Wood stains will not prevent attacks. Wood that is pressure-treated with a preservative should be used if painting is not practical.

Carpenter bees can nest in all species of dried, seasoned wood, but they prefer softwoods, as stated previously. Woods that are soft and that have a straight grain are preferred for easy tunneling. Nail holes, exposed saw cuts, and unpainted wood are attractive starting points for boring. These bees may nest in and damage wood trim near roof eaves and gables, fascia boards, porch ceilings, outdoor wooden furniture, decks, railings, fence posts, telephone poles, siding, shingles, and dead tree limbs.

Figure 87. Carpenter bee damage (Courtesy of Ben Gromicko)

Initially, damage caused by carpenter bees is minor. However, old galleries may be enlarged by the bees and eventually result in considerable wood damage. A gallery can extend for 10 feet if used by many carpenter bees over a period of years. Carpenter bees may refurbish an existing tunnel instead of boring a new one, or they may construct new tunnels near old ones, with infestations persisting for many years.

Sometimes, several carpenter bees use the same piece of wood. If more than one bee uses the same entrance hole, their tunnels will extend in opposite directions or run parallel to each other.

Treatment involves applying insecticide into the tunnel entrance. The opening should be treated after dark when the bees are less active. The holes should be plugged but should also allow the bees to pass freely so that they can contact the insecticide. The holes should be completely filled a day or two after initial application to prevent the bees' further use.

Control and Management of Carpenter Bees

Carpenter bees drill into the end grain of structural wood or into the face of a wooden member, then turn and tunnel with the grain. Their tunnels should be dusted or injected with pressurized liquid insecticide. This is accomplished by inserting a dusted plug of steel wool or copper gauze in the tunnel, and filling the opening with caulk, wood filler, or a wooden dowel. A dusted plug stops new adults that otherwise would emerge through shallow caulking. Caution should be taken, especially if technicians are working on ladders and if they are not experienced with these rather harmless bees.

Summary

Wood-destroying insects other than termites are capable of causing significant damage to structures, furniture, and other wood products. Pest management professionals must be able to distinguish between wood damage caused by termites and damage caused by other wood-destroying pests. The signs are often characteristic of the specific pest species involved. Proper identification of the pest species will allow application of the appropriate control techniques. In many cases, habitat alteration (such as reduction of moisture in wood) is all that is needed to control the pest adequately.

CHAPTER 13: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

T/F: Wood-destroying organisms, other than subterranean termites, cause millions of dollars in damage to wood products each year.

- ○ False
- ◉ True (correct)

T/F: Using kiln- or air-dried wood in construction is one of the least expensive and most practical measures to take in the prevention of WDO infestation.

- ○ False
- ◉ True (correct)

T/F: "Powderpost beetle" is a term used to describe several species of wood-boring insects.

- ◉ True (correct)
- ○ False

Most beetles do not develop in wood whose moisture content is below _____.

- 60 to 80%
- 10 to 15% (correct)
- 35 to 45%

Large quantities of ________ often fall out at exit holes and cracks that house lyctids.

- fecal pellets
- frass (correct)
- food balls
- insect parts

T/F: The most common anobiids attack the sapwood of both hardwoods and softwoods.

- False
- True (correct)

T/F: The most obvious sign of anobiid infestation is the accumulation of powdery frass and tiny fecal pellets underneath infested wood or streaming from their exit holes.

- False
- True (correct)

T/F: Bostrichids are most abundant in the tropics.

- False
- True (correct)

T/F: Carpenter ants use their strong mandibles to consume wood as they enlarge the size of their nests.

- ◉ False (correct)
- ○ True

T/F: The body of a carpenter ant may be black, red, brown, tan, yellow or some combination thereof, depending on the species.

- ◉ True (correct)
- ○ False

T/F: Carpenter ants chew wood with and across the grain, creating irregular, clean galleries.

- ○ False
- ◉ True (correct)

T/F: Carpenter bees consume wood, which can create great structural damage over time.

- ◉ False (correct)
- ○ True

T/F: Painted wood is rarely attacked by carpenter bees.

- ◉ True (correct)
- ○ False

CHAPTER 14: MANAGEMENT OPTIONS FOR WOOD-DESTROYING ORGANISMS (WDO)

This training course is designed to advise students on the proper procedures for inspecting and reporting on wood-destroying organisms/insects. If evidence of wood-destroying insects is found during an inspection, the inspector needs to determine if treatment is necessary and to recommend treatment. On the NPMA-33 form, the box to be checked states: "ACTIVE; treatment recommended at this time."

In many states, any company that treats an insect infestation for hire must have the proper license from the state's Department of Agriculture. Treating for termites, carpenter ants, powderpost beetles, and carpenter bees requires licensing.

An integrated pest-management (IPM) approach involves multiple tactics, such as preventive measures, exclusion, sanitation, and chemicals applied to targeted sites. Homeowners should know that there are various options for insect management. The best treatment option varies, depending on a number of factors, such as type of insect, the severity of infestation, the area being attacked, the potential for re-infestation, and the expense that the customer is willing to bear.

Subterranean Termite Control

Many methods are available for accomplishing termite control and thereby protecting structures from the damage that these insects can cause. The numerous options provide additional flexibility for the termite-control specialist who is knowledgeable about the various methods, technological advances, equipment and tools available, and how to integrate and coordinate the use of these methods to enhance treatment results. The pest management professional (PMP) is able to obtain up-to-date information on termite control by attending training sessions and conferences, reading and reviewing product labels and other literature, and discussing the products with researchers, manufacturers, distributors, and other qualified individuals.

The homeowner can be confused by the many termite-control options on the market. Termites feed slowly, so there is no need to panic, and a few weeks or months may be needed to decide on a course of treatment, which typically requires employing a professional pest management firm. Homeowners are unlikely to have the experience, availability of pesticides, and equipment needed to perform the job effectively themselves.
The homeowner should consider getting at least three estimates before signing a contract for control measures and should be cautious of price quotes that are substantially lower or higher than the others. Prices for termite treatment and conditions of warranties often vary considerably. A guarantee is no better than the firm that presents it. Selecting a reputable pest management firm is of the utmost importance.

The homeowner should deal only with licensed, certified pest management firms having an established place of business and a solid professional reputation. Ideally, such a firm will belong to a city, state or national pest management association. It is a very good idea to consult the state’s licensing agency to determine a firm’s complaint history.

Overall, as part of a termite control program, consideration should be given to removing or changing any condition that exists in or around a structure that aids the termites' ability to gain access to the

structure.
Mechanical alterations are services or functions that can be performed in conjunction with termite-control treatment.
Mechanical alterations may include, but are not limited to:

- removal of wood and cellulose-containing materials from contact with soil in the crawlspace and around the exterior perimeter of the structure;
- correcting excess moisture problems due to faulty grade levels, non-functioning or improperly functioning sump pumps, or faulty gutters and downspouts;
- removing or eliminating soil-to-wood contact of siding, porches, sill plates, steps, etc.; and
- repairing the plumbing, siding and/or roof in order to eliminate leaks or excess moisture.

Soil Termiticide Treatments

Specialized tools and equipment are needed to apply a soil termiticide. Effective termite control often requires several hundred gallons of prepared termiticide solution per house, depending on size, foundation type, etc.

An individual must have knowledge of construction elements and construction types in order to effectively perform termite soil treatments. Termite entry points vary in each foundation type; thus, different soil-treatment procedures may be required. For example, with slab construction, it may be advisable to treat from the outside by drilling through the foundation wall because of the hazard of potentially drilling through heat pipes and ducts, electrical conduits, and plumbing embedded in a slab floor. Mechanical alteration may be necessary depending on the type of construction.

There are many important factors that the PMP should consider when determining which soil termiticide to use and where. Experience actually using a product and knowledge of termite biology and control will undoubtedly help in selecting an effective termiticide.

Some factors to consider include:

- how long the termiticide is expected to be effective;
- the directions and procedures for application, including any issues regarding safety, mixing, concentration, ventilation, etc.;
- the odor characteristics of the termiticide;
- whether the chemical has insect-repellent properties; and
- how the product performs under various environmental conditions, such as damp soil, hard-packed soil, whether the soil is under slabs or in crawlspaces, etc.

Disruptive noise and potential disturbances of different kinds should also be considered. Certain structural elements and conditions, such as a well or cistern within or near the foundation of the structure, a high local water table, problems with the foundation's drainage, the location of sump pump discharge, whether there are nearby lakes or streams, and a variety of other factors require different precautions and strict adherence to the label's directions.

When performed properly according to label directions, soil termiticide treatments provide an effective method to protect structures from infestation and damage by subterranean termites. Pre-treating to prevent termites is a practice that is often employed in regions of the country that have high termite pressure.

Barrier-Type Soil Termiticides

Conventional soil treatments rely on creating a chemical barrier in the soil that is toxic to termites that come into contact with it. Many treatments also have repellent characteristics that cause termites to avoid the treated soil. To achieve termite control for long periods of time, such termiticides must be applied as a continuous barrier in the soil next to and under the foundation. If there are untreated gaps in the soil, termites may bypass the chemical treatment, thus allowing continued infestation or re-infestation of a structure. Soil termiticide treatments during pre-construction can provide for more uniform coverage.

Once a home is constructed, the chemical has to be injected through drill holes and trenching around the foundation, which can result in inadequate coverage. Termiticides may need to be applied to numerous sites, including masonry and other structural components: under slabs, sidewalks, driveways, and porches abutting the foundation, as well as inside hollow foundation walls.

Most pest management firms will refuse to do "spot treatments only" using barrier termiticides, or they will not guarantee such treatments because there is a very high probability that the termites will find other untreated points of entry into the structure. Localized spot treatments are considered risky except in re-treatment situations.

Termiticides that act by creating a chemical barrier in the soil include bifenthrin (Talstar®), cypermethrin (Demon®, Prevail®), and permethrin (Dragnet®, Prelude®).

Treated-Zone Soil Termiticides

The newest termiticides are non-repellent to termites, but they show delayed toxicity as termites forage through treated soil. Termites apparently do not avoid the treated zone, so they contact the active ingredient, which causes delayed mortality and also possibly allows the termites to be overcome by lethal microbes. Furthermore, the toxicant is thought to be passed to nestmates through grooming activities and social food exchange (trophallaxis). Control usually is achieved within three months. As with soil-barrier termiticides, specialized application equipment and large volumes of chemical solution are needed.

Non-repellent termiticides include fipronil (Termidor®), imidacloprid (Premise®), and chlorfenapyr (Phantom®).

Termite Baits

Baits rely on the biological fact that termites are social insects that feed and groom each other; hence, they provide a mechanism for transfer of the chemical throughout their colonies. Because of their social exchange of food (trophallaxis), termites can be affected by a slow-acting toxicant without directly contacting or feeding upon it. Furthermore, baits can have colony-wide effects because individual termites are not site-specific, but instead move freely between numerous interconnected sites during relatively short periods of time. They also intermix with other colony members so that the same group of termites does not simultaneously visit a bait site. Wood or some other type of cellulose is used in termite baits because cellulose (wood) is the food of subterranean termites. The cellulose is impregnated with a slow-acting toxicant that cannot be detected by the termites. The toxicant is designed to be slow-acting because termites tend to avoid sites where sick and dead termites accumulate. Termite workers feed on the treated material and carry it back to other colony members, where it slowly poisons the termites and eventually reduces or eliminates the entire colony.

The toxicant in a number of bait systems is classified as a chitin synthesis inhibitor (CSI). CSIs disrupt the termites' normal molting process, causing them to die in the process of shedding their exoskeleton (molting). CSIs can achieve their effects because worker termites continue to molt periodically throughout their lifetime, and they comprise the majority of the colony. Futhermore, workers feed other colony members, which starve as the worker population is depleted.

Typically, in-ground stations are inserted in the soil next to the structure and in the vicinity of known or suspected sites of termite activity. In-ground stations usually contain untreated wood that serves as a monitoring device. The monitoring wood is replaced with the toxicant once termites have been detected to be feeding on it. In addition, above-ground stations may be installed inside or on the structure in the vicinity of damaged wood and shelter tubes. Above-ground stations initially contain bait. The use of above-ground stations in combination with in-ground stations can enhance delivery of the bait toxicant to the colony.
Successful termite baiting necessitates proper installation, monitoring and maintenance of the stations.

It is very important that bait systems are diligently serviced. Some bait systems are labeled for monthly inspections, and others are designed for quarterly inspections.

Baits work much more slowly than soil termiticides, and the homeowner should be aware of the possibility of a lengthy baiting process. Several months or more may elapse before the termites locate stations, then termites must feed on sufficient amounts of the toxicant.

An often-cited advantage of termite baits is that they are environmentally friendly because they use very small quantities of chemical and decrease the potential for environmental contamination. In addition, bait application causes little disruptive noise and disturbance compared to soil treatments. Furthermore, baits can be used in structures with wells or cisterns, sub-slab heating ducts, and other features that may preclude a soil treatment. Baits are often used in sensitive environments.

Bait systems are frequently offered as an ongoing service due to the fact that a chemical barrier is not established, and when baiting is discontinued, no residual chemical remains. Termite baiting is a complex subject.

A number of baits has been marketed to control termites. Most are only available to licensed pest management professionals (PMPs), and these include: Sentricon® Termite Colony Elimination System (noviflumuron [Recruit® IV bait]); Hex-Pro® (hexaflumuron); FirstLine® Termite Defense System (sulfluramid); Exterra® Termite Interception and Baiting System (diflubenzuron [Labyrinth® bait]); Subterfuge® Termite Bait (hydramethylnon); and Advance® Termite Bait System (diflubenzuron).

Not all of these bait systems are equally effective. It is advisable to review the independent research that has been conducted on a particular bait, as some products have been evaluated much more rigorously than others.

Little or no research has been conducted to verify the effectiveness of all over-the-counter termite bait products, particularly those marketed directly to consumers. Spectracide Terminate® (sulfluramid) and Termirid® 613 (borate) can be purchased by homeowners. According to the label, Terminate® is not recommended as sole protection against termites, and an active infestation should be treated by a professional. The label indicates that the product is intended to be used before termites find the home. Terminate® stakes do not replace mechanical alteration and soil treatments. Termirid® can be used to reduce subterranean termite populations.

Treated Wood

Wood treatments are primarily used to supplement other termite control measures because termites are able to attack untreated wood in other areas of a structure. Wood treatments are typically applied to localized areas, and they are generally used in conjunction with a soil treatment or baiting system.

Certain products are used to treat wood to control active termites in the wood, as well as to protect it against termites. Borates (disodium octaborate tetrahydrate [such as Tim-bor®, Bora-Care®, Jecta® and Impel®]) protect wood against termites and wood-decay fungi. These borates are popular products because of their very low odor and long-lasting properties. However, borates are fairly soluble in water, so borate-treated wood should be protected from constant re-wetting. They are not suitable for situations where wood is in direct contact with soil or exposed to rainfall.

The use of CCA (creosote, chromated copper, arsenate) pressure-treated wood in residential settings is no longer approved by the EPA (since January 2004) because of concerns regarding its arsenic content. However, even creosote-treated railroad ties and telephone poles and other CCA-treated wood can, over time, be subject to termite attack. Termites can build mud tubes over treated surfaces. Furthermore, termites can gain entry through cut and cracked ends or areas where the chemical has not sufficiently penetrated.

Physical Barriers

Physical barriers are particularly appropriate during the pre-construction phase to provide protection of the structure from subterranean termites. One such physical barrier is stainless-steel wire mesh (TermiMesh®) that is fitted around pipes, posts and foundations. The newest physical barrier, Impasse® Termite System, contains a liquid termiticide (lambda-cyhalothrin) locked in between two layers of heavy plastic that is installed before the concrete slab is poured. It is supplemented with Impasse® Termite Blocker, which uses special fittings around plumbing and electrical pipes and conduits.

Biological Control Agents

Certain species of parasitic roundworms (nematodes) will infest and kill termites and other soil insects. They have been promoted and marketed by a few companies. Although effective in the laboratory, control is often quite variable under field conditions. Limited success with nematode treatments may be attributed to the ability of termites to recognize and wall off infected individuals, effectively limiting the spread of nematodes throughout the colony. Furthermore, soil moisture and soil type appear to limit the nematode's ability to move in the soil and locate termites.

The fungus *Metarhizium anisopliae* (Bio-Blast®) is a biological termiticide that requires special application and handling techniques. It is labeled for above-ground application to termite infestations in structures, but it is not labeled for application to the soil. The effectiveness of spraying is enhanced when it's applied to many foraging termites because infected termites can pass the fungus to nestmates. However, it is difficult to infect a large enough number of termites for the infection to spread throughout the entire colony. Furthermore, it provides no long-lasting residual activity, and the fungal spores die along with the dead termites. Insufficient research has been conducted to indicate whether this is an effective method for controlling termites.

POWDERPOST BEETLE CONTROL

Powderpost beetles damage wood slowly. Thus, a homeowner should not think that immediate chemical treatment is needed to preserve the structural integrity of their home. A "wait and see" approach often is desirable, especially when there is doubt as to whether the infestation is still active.

Prevention and Exclusion

Infestations often result from improperly dried or stored wood that contained eggs or larvae when placed in the home. Most powderpost beetles are introduced into homes in lumber or finished wood products (e.g., furniture, paneling, flooring, etc.). Lumber that has been improperly stored or dried should not be used, particularly if beetle exit holes are present. Many of the most serious infestations arise when old lumber from a barn or outdoor wood pile is used for home remodeling.

Powderpost beetles only lay their eggs on bare, unfinished wood. Bare wood can be protected from powderpost beetle attack by painting, varnishing, waxing, or otherwise finishing exposed wood surfaces.

Infestations by some bostrichid species can be avoided by removing all bark edges from wood. Beetles that emerge from finished articles, such as furniture, were likely in the wood before the finish was applied. Because many species of powderpost beetles emerging from finished wood can re-infest it by laying eggs in their own exit holes, it is important to seal the holes to prevent this possibility.

Anobiid infestations sometimes occur as the result of beetles flying inside from outdoors or by being carried indoors on firewood. Homeowners should install tight-fitting screens on windows and doors to prevent the entry of flying beetles.

Moisture Control

Powderpost beetles, especially anobiids, have specific moisture requirements for survival and development. Most beetles do not develop in wood with a moisture content below 15%. Wood that has a moisture content of 13% to 30% is preferable for anobiid development or re-infestation.

A moisture meter is useful for predicting potential beetle re-infestation of wood. The moisture content of wood varies seasonally, typically reaching its peak during mid- to late summer, and its lowest levels during winter. The use of a central heating or air-conditioning system to reduce moisture levels to less than 12% can create unfavorable conditions for anobiids.

It is advisable for contractors to install a moisture or vapor barrier in the crawlspace of their clients' homes and buildings. Covering the soil with 4- to 6-mil polyethylene sheeting reduces wood's moisture content. For existing anobiid beetle infestations, installing a moisture barrier greatly reduces the threat of the infestation spreading upward into walls and the upper portions of a building. A moisture barrier may slowly eliminate anobiid beetle infestations by preventing re-infestation.

Increased ventilation also can lower moisture in damp crawl spaces. This can be accomplished by installing foundation vents (one square foot of vent opening per 150 square feet of crawl space area if a vapor barrier is not present; one square foot of vent opening per 300 to 500 square feet of crawl space area if a vapor barrier is present). Make sure that vents are kept open. Remove any vegetation covering vents.

Kiln-Dried Lumber

Powderpost beetle infestation in lumber is usually removed by kiln-drying and wood-processing operations. For new construction, kiln-dried lumber, which is lumber dried a minimum of eight hours at 130° F to 140° F and at 80% relative humidity, should be used.

Wood Replacement

If the infestation appears to be localized (e.g., a few pieces of flooring, molding or paneling), simply removing and replacing infested pieces may solve the problem. If additional holes begin to appear in adjacent areas, additional action can then be taken.

Sub-Zero Temperatures

Powderpost beetle infestations in small, movable items can be eliminated by storage of the items at sub-zero temperatures for approximately 48 hours.

Insecticide Treatment

Control of powderpost beetle infestations in structural wood can be achieved by applying a liquid insecticide to the wood’s surface or by injecting it into the wood. Boron-based insecticides are effective in controlling powderpost beetles. These products tend to penetrate deeply into the wood to kill some of the larvae, and they are highly effective in preventing re-infestations. Effective control can be obtained by thoroughly spraying all exposed wood surfaces in crawlspaces and outbuildings with a boron-based insecticide. Liquid can also be pressure-injected into the larval galleries through small holes drilled in the damaged wood. When wood is protected from the weather, such as in crawlspaces, boron-based products have a long residual lifetime.

A pyrethroid can be pressure-injected into wood to provide quick contact-kill. Copper compounds are available for application to wood. Penetration on wood surfaces is only about 1/8-inch and protection is much shorter than that provided by CCA-treated wood.

Fumigation with an insecticide usually provides immediate control of all beetle life stages within the wood. However, this method is expensive and it provides no residual protection against beetle re-infestation. Infestations in small, movable items can be eliminated by fumigation. Tent fumigation of a structure is not always warranted, although it may be the best choice for infestations of tropical species of bostrichids.

CARPENTER ANT CONTROL
Prevention

Homeowners should trim all trees and bushes so that branches do not touch or come in contact with the house. High moisture conditions must be eliminated to help control carpenter ants. Moisture problems can arise from: leaking roofs, chimney flashing and plumbing; poorly ventilated attics and crawlspaces; and blocked gutters. Rotted and water-damaged wood should be replaced, and all wood-to-soil contact points should be eliminated.

Homeowners should also remove dead stumps within 50 feet of the house (if practical), and repair trees with damage at broken limbs and seal holes in the trunk. They should also seal cracks and crevices in the foundation, especially where utility pipes and wiring extend from outside. Homeowners should also be sure to store firewood off the ground and away from the house. They should also consider using non-organic mulches near the house in heavily infested ant areas.

Insecticide Treatment

The most important and often the most difficult part of controlling carpenter ants is in locating their nests. More than one colony may be present in the structure or on the property. Once the nest locations are found, control measures can be implemented. The nests can be removed physically (for example, by using a vacuum) or by using an insecticide treatment.

Chemical flushing agents can be used to locate nests. A household aerosol spray containing pyrethrins and piperonyl butoxide can be applied directly into cracks, crevices and holes. The chemical will excite the ants by its repellent action and cause them to come running out, thereby revealing the location of their nest, in some instances.

Without locating and treating the nest, spraying or dusting the baseboards, cracks and crevices around the infested area with residual insecticides usually does not give complete control. Foraging workers will contact the insecticide and die, but ants staying inside the galleries of the nest, along with the queen and developing larvae, may not be affected to any great extent.

If the nest is located in a wall void, it is best to apply a dust via drill holes to help the insecticide penetrate. Treatment should be applied 3 to 6 feet on either side of where ants are entering to (hopefully) contact the nest.
A series of holes can be drilled at 12-inch intervals in infested timbers to intercept cavities and galleries of the nest. The holes can later be sealed by plugging them with dowels, small corks or an appropriate sealant, and then touched up with paint, which will leave no visible damage from the repairs.

Aerosol spray treatments to the nest can be effective, particularly if much insulation is present. Insecticidal vapors can spread within the wood to penetrate inaccessible areas of the nest, aiding in colony eradication. Approaches and areas adjacent to the nest must be thoroughly treated with residual insecticides.

Perimeter treatments are used outside the structure to prevent ant entry. All breaks where ants can enter the home need to be treated, and a perimeter spray should be applied against the foundation wall at least 2 feet up and 3 feet out. The treatment should be applied under the lower edge of siding, around window and door frames, and around the chimney flashing. During the summer, a perimeter treatment should be re-applied every four to six weeks, or within a week after a heavy rain.

Baits can sometimes provide control. Baits need to be a readily accepted food source that is carried back by the pests to their nesting sites to eliminate the queen, brood and workers. Indoors, baits need to be contained in childproof bait stations. Outdoors, liquid and granular formulations often are used.

CARPENTER BEE CONTROL

Prevention

All exposed wood surfaces should be painted with an oil-based or polyurethane paint to reduce attack by carpenter bees. Wood stains will not prevent damage. If practical, damaged wood should be removed and replaced with chemical pressure-treated wood to discourage nest construction. Also, alternative building materials can be used, such as aluminum, asbestos, asphalt, vinyl siding, and similar non-wood materials that are not subject to damage by carpenter bees.

Insecticides

Dust applications leave more residue and are more effective than sprays due to the nature of the bees' gallery construction. Even newly emerged bees will contact the dust when leaving the opening. Tunnel entrances should be located during the daytime, but treatment should be applied after dark during a cool evening when carpenter bees are less active. Those applying the insecticide should take care to wear protective clothing to avoid any stings during treatment. Treatment should be applied directly into the nest entrance and on a wide area of adjacent wood surfaces. The entrance holes should not be plugged since bees should be allowed to pass freely to distribute the insecticide within their galleries. If tunnels are plugged before the bees are killed, they may chew new openings elsewhere. After treatment, it may be a good idea to wait until adult activity ceases or until autumn before sealing the hole with caulking compound or wood putty, which reduces wood deterioration and possible future infestation.

Comparative biological information on the three families of powderpost beetles.

Family			
Characteristic	**Bostrichid beetles, false powderpost beetles (Bostrichidae)**	**Anobiid beetles (Anobiidae)**	**Lyctid beetles, true powderpost beetles (Lyctidae)**
Shape and size (inches) of exit holes	Round 3/32 to 9/32	Round 1/16 to 1/8	Round 1/32 to 1/8
Age and type of wood attacked	Raw and new hardwoods (only the sapwood portion of U.S. tree species; sapwood and heartwood of tropical	New and old hardwoods and softwoods with >12% moisture content. Prefer sapwood; rarely occur in heartwood.	New hardwoods with >3% starch (only sapwood portion of U.S. tree species; sapwood and heartwood of tropical
Frass texture and packing	Fine to coarse powder tending to stick together; tightly packed in tunnels.	In softwoods, fine powder with elongate lemon-shaped pellets; loosely packed in tunnels. In	Very fine powder (consistency of talcum powder); loosely packed in tunnels
Insect body shape	Cylindrical, roughened pronotum	Oval, compact	Flattened
Insect body color	Brown to black	Reddish brown	Brown to black
Insect head visible from above	No	No	Yes
Required moisture content	6 to 30 percent	13 to 30 percent	6 to 30 percent
Average life cycle	1 year	1 to 3 years	1 year

Timbers Attacked by Common Wood-boring Insects						
	Unseasoned	Seasoned	Softwood	Hardwood	Sapwood	Heartwood
Lyctids		Yes		Yes	Yes	
Bostrichids	Occasionally	Yes	Occasionally	Yes	Yes	
Anobiids		Yes	Yes	Occasionally	Yes	Occasionally
Round-headed borers	Yes		Yes	Yes	Yes	Occasionally
Old house borers		Yes	Yes		Yes	
Flat-headed borers	Yes	Occasionally	Yes	Yes	Yes	Yes
Wharf borers		Yes	Yes	Yes	Yes	Yes
Scolytids	Yes		Yes	Yes	Yes	Yes

CONTROL OF POWDERPOST BEETLES

Inspection

Periodic inspections are needed to determine the condition of wood and to locate any evidence of attack by wood-destroying beetles. The inspector should visually examine all exposed surfaces of wood (painted and unpainted); also, tap the wood to hear whether it's sound, or probe the wood with a knife. Interview the homeowner or building occupants and ask whether they have noticed any signs of beetle infestation, such as beetles, holes in wood, frass, etc. Look for evidence of beetle attacks in attics, crawlspaces, unfinished basements and storage areas. The signs are more likely to be undisturbed in these areas, and the absence of finishes on wood leaves more wood surface exposed to re-infestation.

Collect beetles, larvae, frass, wood samples, and any other evidence that needs to be closely examined with good light and magnification to determine the identification of the attacking beetles. To be certain that the infestation is active, try to find fresh frass, which is the color of newly sawed wood, or live larvae or adults in the wood.

The alteration of environmental conditions might one day be the only procedure necessary to eliminate some infestations of wood-boring beetles. No wood-destroying beetles in buildings develop rapidly in dry wood. If the use of vapor barriers, ventilation, and central heat can dry wood and keep it dry, the use of other control measures may not be necessary.

Here are some techniques that can be used to reduce favorable habitats for wood-destroying beetles:

- A moisture meters can be used to determine the moisture level in the wood. Every effort should be made to reduce the moisture content of the wood to be protected to below 20%.
- Where economical and practical, infested wood should be removed and replaced.

- Electric-current treatment and heat control may be used in some wood-boring beetle infestations.

Every situation of wood-boring beetle infestation needs to be evaluated before recommending the appropriate treatment method or combination of methods.

Pesticide Application

There are certain similarities in the measures recommended for the control of wood-boring beetles, but in many instances, specialized techniques are required. If it can be determined that the damage in a particular situation was caused by one of the true powderpost beetles, it will be necessary to concentrate control activities on the articles made of hardwoods. In most cases, this will involve a thorough application of insecticide to all exposed hardwood surfaces.

If the infestation involves bostrichid or anobiid beetles, the scope of the treatment should be altered to some extent. Unless the PMP can make a definite determination as to species and thereby establish the various woods subject to attack, it must be assumed that the pest endangers both softwoods and hardwoods. In addition to determining the type of wood being attacked, each problem must be analyzed in light of the severity of the infestation, the possibility of re-infestation, the area of the structure being attacked, the speed of control needed, and the cost that the property owner can bear. Some guidelines follow.

- In most cases, residual sprays provide effective control. Sprays should be applied at low pressure (to reduce splashing) using a flat-fan nozzle to obtain thorough coverage.
- The best penetration to tunnels is provided by a fumigant, but there is danger in handling these materials and they they have no effective residual life, so these factors limit their desirability. Fumigation may be necessary when it is impossible to control powderpost beetles via insecticidal sprays. An example is when the beetles have moved into walls and other inaccessible areas.
- Water-based insecticide emulsions are generally considered safer and more effective than oil-based emulsions. Oil solutions present a possible fire hazard, greater expense, greater hazards, and greater discomfort to the applicator, as well as the potential to damage plants near the treatment area.
- Treated surfaces should not be walked on or handled until they have thoroughly dried.

In treating finished wood, such as furniture or flooring, it is best to use an oil solution to avoid spotting or in any way changing the appearance of the finish. To be certain that an oil-based solution will not damage the wood's finish, a small amount should be applied on a hidden area and allowed to dry before administering a complete treatment. Insecticide should be applied to the entire surface of the infested wood using a flat-fan nozzle at low pressure, or by using a soft-bristled paintbrush. If there are only scattered patches of infestation, only the infested boards should be treated. Over-treating should be avoided (i.e., until the solution runs off or puddles), particularly on hardwood floors laid over asphalt paper or asphalt-based mastic. The asphalt will be dissolved by excess oil and may bleed through the finished floor. Any excess solution should be wiped up immediately. If the spray has temporarily softened the finish, care should be taken not to touch and mar the surface. An oil carrier may have a solvent action on some wood finishes. Therefore, all objects should be kept off treated areas for about 24 hours, or until all stickiness has disappeared.

Follow-Up

The homeowner, applicator or inspector should check for signs of re-infestations of lyctid and anobiid beetles. Bostrichid beetles will rarely re-infest structural timbers.

OTHER WOOD-INHABITING INSECTS

A variety of insects may be found in wood during the course of a WDO inspection. According to the guidelines from the National Pest Management Association for completing the NPMA-33 form, inspectors are not required to report insects that are considered to be non-re-infesting insects. At the discretion of the inspector, non-re-infesting insects may be reported in the comments section of the NPMA-33 form or in an attachment for disclosure purposes.

There are several species of insects that infest dying, freshly felled trees or unseasoned wood, but do not re-infest seasoned wood. They may emerge from wood in a finished house, or evidence of their presence may be observed. On rare occasions, control measures may be justified to prevent disfigurement of wood, but control is not needed to prevent structural weakening.

Many beetles in the families *Buprestidae, Cerambycidae, Platypodidae,* and *Scolytidae* do not re-infest dry, seasoned wood. Their previous feeding damage may be evident. It is important to distinguish damage caused by non-re-infesting insects from damage caused by beetles that can re-infest seasoned wood. Non-re-infesting adult beetles initiate their attacks in the moist wood of recently dead and dying trees, as well as in drying logs and lumber, where their larvae begin their development. Note that the larvae may complete their development in wood after it is dry. These beetle infestations are usually removed by kiln-drying and wood-processing operations. No control measures are needed because these beetles cannot infest the bark-free, dry wood in a structure.

WOOD-BORING WEEVILS

Family *Curculionidae*

Though they are not particularly common, several species of weevils will infest structural timbers. Because they are found in wet and rotting wood, they are considered a secondary problem to the wood rot. They are capable of extensive tunneling and will make a wood rot problem far worse.

Weevils are easily recognized by their elongated snout. The wood-boring weevils are small insects, about 1 inch long. They leave small tunnels, about 1/16-inch in diameter, in the heartwood or sapwood of softwoods, hardwoods, and even plywood.

Control is usually restricted to the removal and replacement of damaged wood. The wood is frequently already damaged by moisture by the time the weevils arrive. It may be appropriate to lower the moisture of the wood in conjunction with an application of borate insecticides, but such decisions will need to be made on a case-by-case basis.

igure 6.12. Wood-boring weevil, *Cossonus* spp. (H. Russell, lichigan State University Diagnostics Services).

Figure 88. Wood-boring weevil, Cossonus spp. (H. Russell, Michigan State University Diagnostics Services)

Ambrosia Beetles

These insects attack unseasoned sapwood and heartwood of softwood and hardwood logs, producing circular boreholes up to 1/8-inch in diameter. They do not consume wood. Ambrosia beetles tunnel through wood; they do not eat it. The adults and larvae feed on fungus, called ambrosia, which grows in the excavated galleries. The fungus leaves a distinctive dark blue to black stain on the tunnel walls and around the beetles' emergence holes. This can often be observed in lumber where the milling process has cut through galleries.

Ambrosia beetles excavate round tunnels, and their frass is typically compacted into wicks on the wood surface. Ambrosia beetles are found most often in log homes built with freshly cut logs. These insects do not infest seasoned wood.

Bark Beetles

These beetles tunnel at the wood/bark interface and etch the surface of the wood immediately below the bark. Bark beetles are sometimes called "engraver" beetles because they carve elaborate galleries in wood. Bark beetles attack raw hardwoods and softwoods, but they feed only on the inner bark and the sapwood surface. The larvae feed while the bark is in place. Their tunnels are round, and some contain tightly packed, fine to coarse powder. Wood that has been etched by bark beetles is sometimes incorporated into a structure. Beetles left under bark edges on lumber may survive for a year or more as the wood dries. Some brown, gritty frass may fall from circular boreholes in the bark that have a diameter of 1/16- to 3/32-inch. These insects do not infest wood.

Horntails (Wood Wasps)

Horntail wasps are large insects, often more than 1¼-inches long. If these large wasps emerge from finished walls in a structure, then the larval or pupal stage actually was present in the wood when the structure was built. One species sometimes emerges in houses from hardwood firewood. Horntails occasionally emerge through paneling, siding or sheetrock in new houses. It may take four to five years for them to emerge.

Horntails attack both sapwood and heartwood, producing a C-shaped tunnel in a tree. Exit holes and tunnels are circular in cross-section, with a diameter of 1/6- to 1/4-inch. Tunnels are tightly packed with coarse frass. These tunnels are frequently exposed on the surface of lumber by milling after the development of the insect.

Horntail wasps may cause cosmetic damage, but they do not pose a risk to the structure. They will not re-infest wood in a structure. The female horntail wasp may sting if handled.

Round-Headed Borers

Several species are included in this group. They attack sapwood of softwoods and hardwoods during storage, but rarely attack seasoned wood. The "old house borer" is the major round-headed borer that can re-infest seasoned wood. The old house borer is an introduced species. It is common in the U.S. along the Eastern Seaboard, but is occasionally found in states further inland, such as Ohio. Contrary to its name, the old house borer is found primarily in structures that are less than 10 years old.

When round-headed borers emerge from wood, they make slightly oval to nearly round exit holes that are 1/8- to 3/8-inch in diameter. Their frass varies from rather fine and meal-like for some species, to very coarse fibers resembling pipe tobacco for others. Frass may be absent from tunnels, particularly where the wood was machined after emergence of the insects.

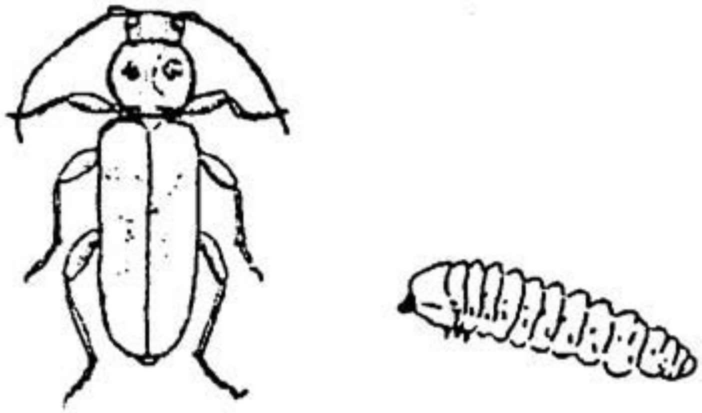


Figure 89. Old house borer adult and larvae

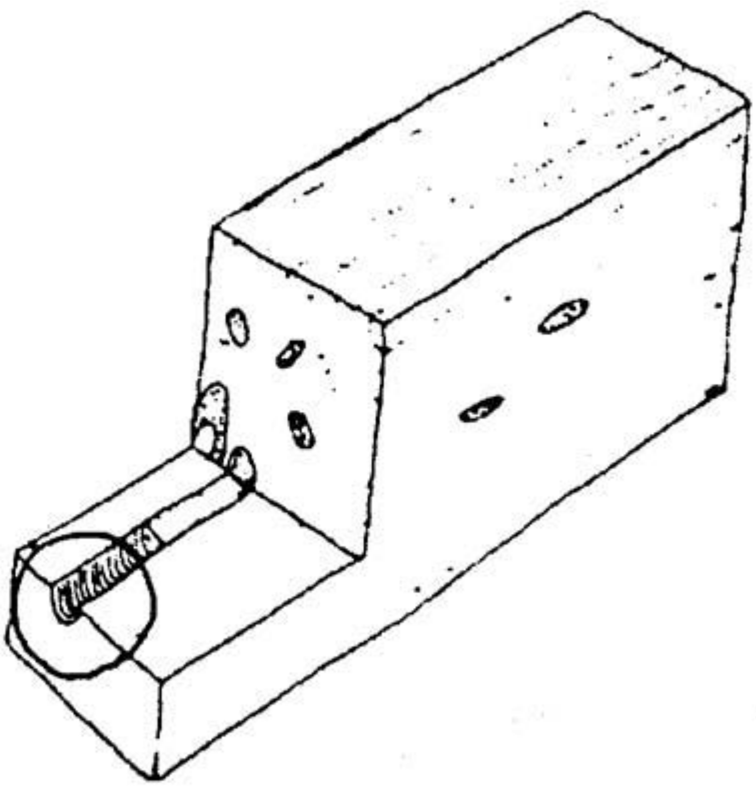


Figure 90. Emergence hole of an old house borer

The larvae of the old house borer feed on the sapwood of softwood timber, including pine, fir and spruce. Larval development occurs most rapidly in wood with a moisture content of more than 10% and high nutrient levels, and when the temperature is 68° F to 88° F, with a relative humidity of 80 to 90%. Depending on these environmental conditions, the old house borer spends from two to 10 years in the larval stage. Although the old house borer can re-infest a structure, centrally heated and well-ventilated structures are unlikely to harbor an ongoing infestation.

Wharf Borer

The wharf borer is a soft-bodied, yellowish-tan beetle with black tips on its wing covers, and approximately 1/2-inch long. The antennae are less than half the length of the body. The wharf borer is an introduced species. The larvae live in rotted wood that is nearly saturated with water. They are of particular concern in wharves, pilings, and waterfront properties.

When large numbers of adults occasionally emerge within a structure, the source of these beetles is usually rotted wood buried below the structure.

Flat-Headed Borers

These attack the sapwood and heartwood of softwoods and hardwoods. Their exit holes are oval, with the long diameter 1/8- to 1/2-inch. Wood damaged by flat-headed borers is generally sawed after damage has occurred, so tunnels are exposed on the surface of infested wood. Tunnels are packed with sawdust-like borings and pellets, and tunnel walls are covered with fine transverse lines somewhat similar to some round-headed borers. However, the tunnels are much more flattened.
The golden buprestid is one species of flat-headed borer that is occasionally found in the Rocky Mountain and Pacific Coast states. It produces an oval exit hole 3/16- to 1/4-inch across, and may not emerge from wood in houses for 10 years or more after initial infestation of the wood. It does not re-infest seasoned wood.

If signs of insect or fungus damage other than those already described are observed, the inspector should have the organism responsible identified before recommending corrective measures. Small samples of damaged wood, with any frass and insect specimens (with larval or grub specimens stored in vials filled with alcohol) should be taken to the local Cooperative Extension Office for identification.

LONGHORNED BEETLES

Family *Cerambycidae*

Species in this family (and more than 1,200 species have been recorded in the United States) feed as larvae on living trees, recently felled trees and logs, and seasoned lumber. Indoors, the only species of major economic importance that can re-infest dry, seasoned wood is the old house borer (*Hylotrupes bajulus*). Larvae hollow out extensive galleries in seasoned softwood, such as pine. The old house borer is frequently a pest of new structures, although it is also found in older buildings.

Adults are about 3/4-inch long and grayish-brown to black with two white patches on the elytra. The dorsal surface is densely covered with light-colored hairs. On the pronotum are two black, shiny bumps. The long, gray hairs surrounding these bumps convey an owl-like appearance.

Figure 91. Old house borer adult (Cerambycidae) Hylotrupes bajulus (H. Russell, Michigan State University Diagnostics Services)

The beetles of this family lay their eggs in cracks and crevices in bark and on the surface of rough-sawn timbers. The larvae are wood borers. Mature larvae are large, from 1/2-inch up to 3 or 4 inches long. The body is long and narrow and of a light cream color. The rear portion of the head is partly drawn into the body so that only the mandibles and other mouthparts can be easily seen. The larvae are called round-headed borers.

The life cycle of the old house borer ranges from three to 12 years. Because this beetle has a very long life cycle and can infest the same piece of wood again and again, it may be many years before serious structural damage is recognized. The exit holes of emerging adults do not occur in very large numbers until the infestation has been established for several years.

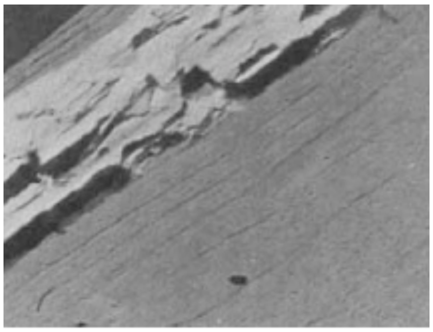


Figure 92. Old house borer damage with oval exit holes and powder-filled galleries in interior of wood

This, along with the fact that larvae will do extensive feeding without breaking through the surface of the wood, make it necessary to inspect infested wood very carefully to detect old house borer damage.

Control and Management of Longhorned Beetles

Rough wood should be probed or struck to detect weaknesses or the presence of boring dust. If exit holes are present, they will be broadly oval and about 1/4- to 3/8-inch in diameter.

Habitat Modification

A common source of these beetles is firewood brought indoors. Thus, firewood should be brought indoors only when it will be used soon afterward.

Keeping wood dry will slow down larval development. Larvae grow faster in wood that provides a protein source in the form of wood-decaying fungi.

Pesticide Application

Control programs involve only the treatment of softwoods, to which this pest is restricted. Infestations of this beetle often involve extensive excavations, and larvae may be found a considerable distance from the obvious points of infestation. If the infestation is too widespread for spot treating with residual sprays, fumigation may be necessary. Other long-horned beetles require no control.

Follow-Up

Careful and thorough inspection is necessary to determine the extent of a newly discovered infestation.

Old house borers are the only longhorned beetles that will re-infest structural timbers, and damage may not be noticed for several years.

Characteristics of damage by wood-boring beetles that may be associated with wood in use.

Beetle common names (family)	Shape & size (inches) of exit holes	Age & type of wood attacked	Characteristics of tunnels and frass
Old house borer, roundheaded borer (Cerambycidae)	Oval 1/4 – 3/8	New softwoods; only sapwood. Old softwood if >10% moisture content.	Oval tunnels tightly packed with slightly granular frass composed of tiny, barrelshaped pellets and wood fragments. Tunnel walls with ripple marks.
Woodboring weevils (Curculionidae: Cossoninae)	Round Ragged edges 1/16 – 1/12	New and old hardwoods and softwoods; only very damp sapwood and heartwood.	Round tunnels tightly packed with very fine, powdery frass and very tiny pellets.
Flat oak borer, roundheaded borer (Cerambycidae)	Round to oval 1/8 – 1/4	Raw and new hardwoods, primarily oak; sapwood and heartwood. Adults may emerge from old wood in damp sites.	Fine, granular powder; loosely packed in tunnels.
Ambrosia beetles (Scolytidae) & pinhole borer (Platypodidae)	Round 1/50 – 1/8	New hardwoods and softwoods; sapwood and heartwood. Rare in raw wood. Adults attack new or old wood that is rewetted or covered with certain paints or solvents.	Round tunnels lacking frass, but frass often compacted into wicks on surface. Tunnel walls often stained dark blue to black.
Bark beetles, Ips beetles, scolytid beetles (Scolytidae)	Round 1/16 – 3/32	Raw hardwoods and softwoods; only inner bark and surface of sapwood.	Round tunnels, some with tightly packed fine to coarse powder, which is a mixture of dark and light wood fragments.
Metallic wood borers, flatheaded borers, buprestids (Buprestidae)	Oval 1/8 – 1/4	Raw hardwoods and softwoods. Adults may emerge after >2 to 10 years.	Flattened oval tunnels tightly packed with sawdust-like frass. Ripple marks on walls.
Longhorned beetles, roundheaded borers, cerambicids (Cerambycidae)	Round to oval 1/8 – 3/8	Raw hardwoods and softwoods. Common in firewood and log homes. Eburia spp. may emerge from old wood.	No frass in tunnels, or coarse to fibrous frass loosely packed in tunnels.

CHAPTER 14: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

T/F: Treating for termites, carpenter ants, powderpost beetles and carpenter bees requires licensing.

- (•) True (correct)
- ( ) False

T/F: Termites feed slowly so there is no need to panic, and a few weeks or months may be needed to decide on a course of treatment, which typically requires employing a professional pest management firm.

- ○ False
- ◉ True (correct)

T/F: Effective termite control often requires only a few quarts of prepared termiticide solution per house, depending on size, foundation type, etc.

- ◉ False (correct)
- ○ True

Conventional soil treatments rely on creating a chemical ________ in the soil that is toxic to termites that come into contact with it.

- ○ nutrient
- ○ paralytic
- ○ passageway
- ◉ barrier (correct)

________ rely on the biological fact that termites are social insects that feed and groom each other, thereby providing a mechanism for transfer of the chemical throughout their colonies.

- ○ Chemical treatments
- ○ Parasitic roundworms
- ○ Physical barriers
- ○ Wood treatments
- ◉ Baits (correct)

A(n) _________ is useful for predicting potential beetle re-infestation of wood.

- ○ property owner
- ○ infrared camera
- ◉ moisture meter (correct)

- calendar
- sharp tool

T/F: Control of powderpost beetle infestations in structural wood can be achieved by applying a liquid insecticide to the wood's surface or by injecting it into the wood.

- True (correct)
- False

To control __________, homeowners should trim all trees and bushes so that their branches do not touch or come into contact with the house.

- carpenter ants (correct)
- powderpost beetles
- moisture
- carpenter bees
- anobiid infestation

All exposed wood surfaces should be painted with an oil-based or polyurethane paint to reduce attacks by __________.

- carpenter ants
- subterranean termites
- carpenter bees (correct)
- Formosan termites

CHAPTER 15: PREVENTING TERMITE DAMAGE

Construction Practices

Conditions under which termite colonies thrive are rather rigid. Because of this, certain steps taken during planning and construction of a building greatly reduce or prevent future termite damage.

Improper design and construction of buildings, resulting perhaps from a lack of knowledge of or an indifference to the termite problem, can leave structures vulnerable to infestation.

It is important to stress the value of good building practices and chemical treatment of soil during construction. The objective of preventive procedures is to prevent termite access to wood and moisture.

Building Site

The most important rule in avoiding termite problems is to prevent direct contact of soil with untreated wood. Whenever possible, roots, stumps and other wood debris should be removed from the building site before construction work is started. Spreader sticks and grade stakes should be removed before the concrete sets. Form boards and scraps of lumber should also be removed before filling or back-filling around the completed foundation. Wood should not be buried beneath porches and steps. No scraps of lumber should be left on the soil surface beneath or around the building following construction. Removal of all these materials reduces the likelihood of future termite infestation.

To prevent unfavorable moisture buildup in the soil beneath a building, the soil surface should be graded so that surface water will drain away from the building. Proper connection of eaves, gutters and downspouts to a storm-sewer system helps. On flat sites and around buildings with basements, the use of drainage tile around the outside of the building is also helpful.

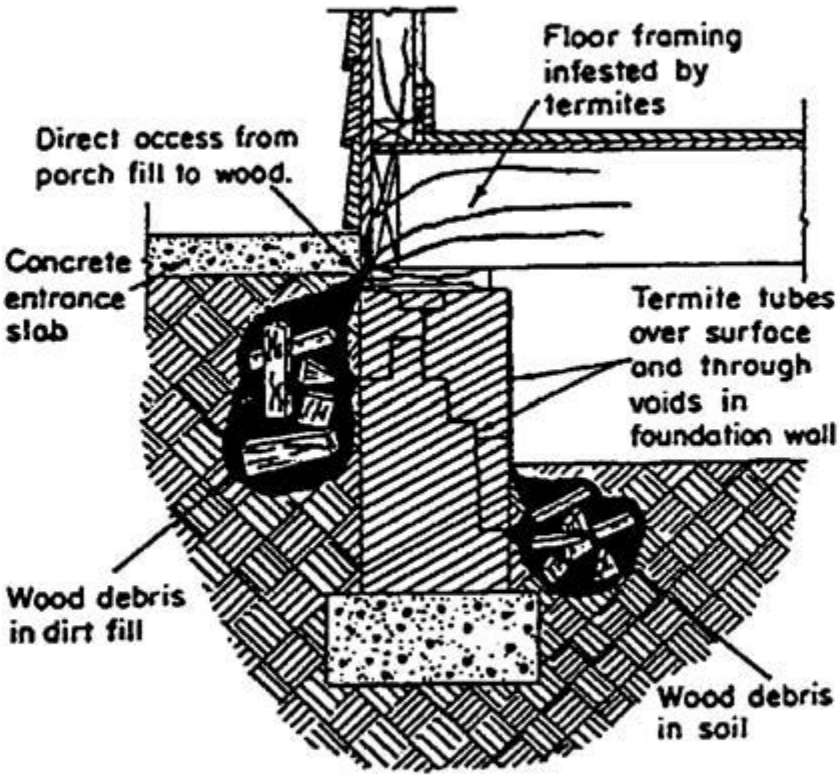


Figure 93. Termite colonies can develop in wood debris and soil and gain entrance into a building, particularly at the concrete entrance slabs of porches.

Wall and Pier / Crawlspace Structure

All foundations should be made as impenetrable to termites as possible to prevent hidden access to woodwork located higher in the structure. This is one of the most important protective measures that can be addressed during construction.

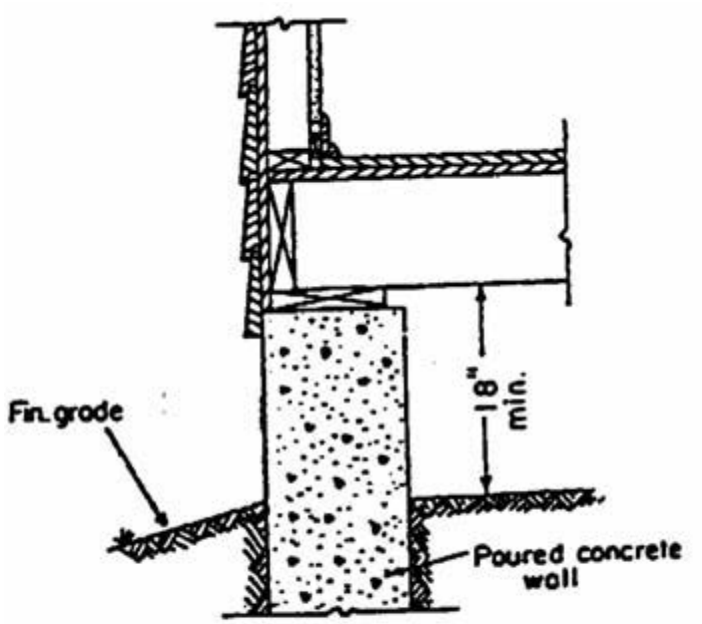


Figure 94. Poured concrete wall and pier foundation

Foundations may be rated in decreasing order of resistance to termite penetration as follows:

1. A poured concrete foundation that's properly reinforced helps prevent large shrinkage and settlement cracks. Termites can enter through cracks as small as 1/64-inch wide.

2. For hollow-block and brick foundations and piers, the following measures can be utilized:
    - cap with a minimum of 4 inches of reinforced poured concrete;

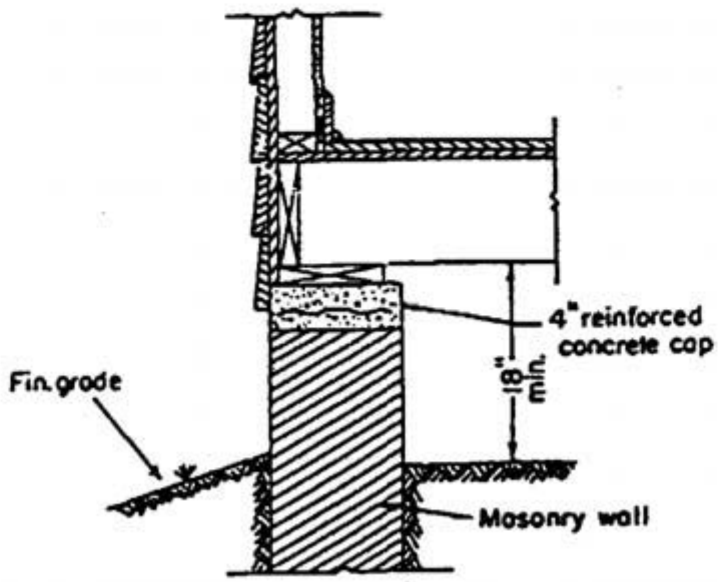


Figure 95. A reinforced poured concrete cap on masonry walls or pier

- cap with precast solid concrete blocks, with all joints completely filled with cement mortar or poured lean grout;
- the top course of blocks and all joints should be completely filled with concrete. Where hollow blocks are left open, no protection is provided, and this type of construction cannot be treated without serious odor problems.

3. Wooden piers, or posts used for foundations or piers, should be pressure-treated with an approved preservative by a standard pressure process and properly set on concrete bases with a top surface above grade.

Raised Porches and Terraces of Concrete and Masonry

Dirt-filled porches and terraces account for a large proportion of termite infestations in buildings. Therefore, spaces beneath concrete porches, entrance platforms and similar raised units with soil should not be filled. If possible, such spaces should be left open for inspection and access doors installed for that purpose. If this cannot be done, or if the spaces beneath raised units must be filled, a clearance of 6 inches should be left between the soil and wood, and the soil treated with an insecticide (see section on Soil Treatment).

Clearance Between Wood and Soil

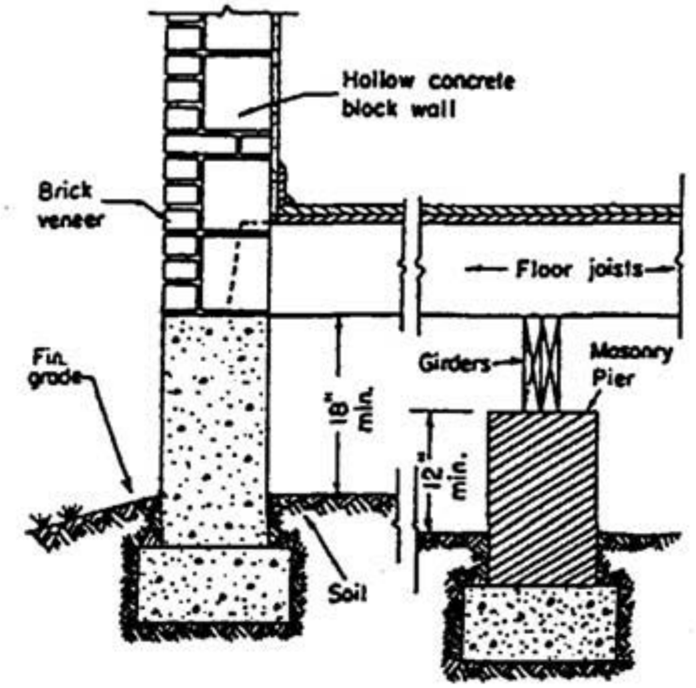


Figure 96. Adequate clearance should be provided between wood and soil both outside and inside the building.

The outside finished grade should always be at or below the level of soil in a crawlspace underneath the structure so that:

- water is not trapped underneath the house; and
- the foundation wall is exposed and can be inspected.

The exterior siding should be at least 6 inches above the outside grade and should not extend down more than 2 inches below the top of the foundation walls, piers and concrete caps. This will force termites into the open where their tunnels can be seen before they reach the wood.

In crawlspaces, the minimum clearance between the ground and the bottoms of floor joists should be 18 inches. The clearance for girders should be at least 12 inches.

Metal Termite Shields

Another method for preventing hidden termite entry is by means of termite shields, which are sometimes used instead of the concrete cap or other methods of sealing masonry unit foundations.

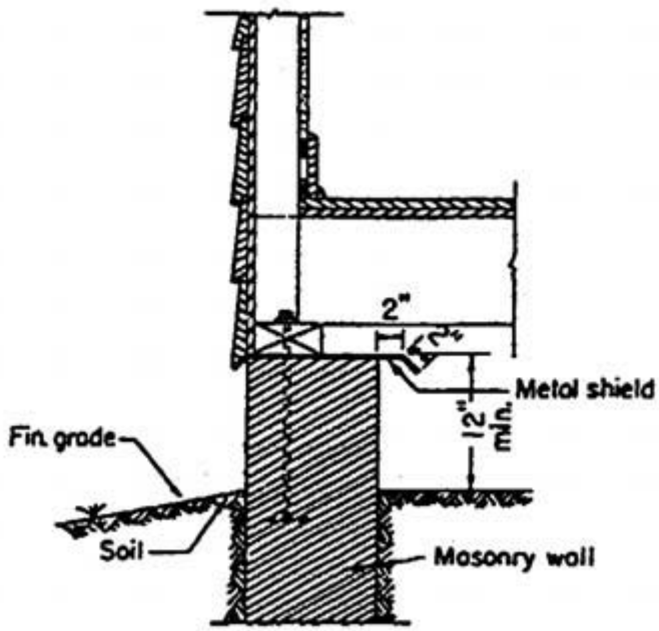


Figure 97. Termite shield over uncapped masonry wall showing minimum clearance from ground on both inside and outside of foundation

Properly designed, constructed, installed and maintained metal shields will force termites into the open, revealing any tunnels constructed around the edge and over the upper surface of the shields. However, experience has shown that good shield construction and installation are rare. Also, no termite shield has yet been developed that is absolutely effective in preventing the passage of termites because termites can construct tubes on the lower surface of a shield. Occasionally, one of these tubes will extend around the edge and up and over the upper surface. Frequent inspection for the presence of such tubes, therefore, is essential.

Shields are used primarily for protecting portions of buildings above ground. They are suited for unit masonry piers. They are not effective in safeguarding finished rooms in basements. Termites can enter these rooms through expansion joints, crevices in the foundation wall, or cracks in the floor. Shields should not be installed in the slab-on-ground construction. Because of the problems previously mentioned, termite shields are not currently recommended for the detection and prevention of termite infestations.

Ventilation Beneath Buildings

In buildings with crawlspaces, ventilation openings in foundation walls should be large enough and placed properly to prevent pockets of dead air from forming. These pockets help create humid conditions that favor termite activity and wood decay. Openings placed within 3 feet of the comers of a building usually give the best cross-ventilation. The size and number of openings depend on the soil's moisture level, the atmospheric humidity, and air movement. In general, the total area of ventilation openings should be equivalent to 1/150 of the ground area beneath the dwelling. Shrubbery should be kept far enough away from the openings to permit free circulation of air, as well as far enough away from the foundation to allow inspection of wall surfaces for termite tubes.

Where there is a tendency for moisture to accumulate in crawlspaces or where adequate ventilation is difficult to achieve, it is advisable to place a vapor barrier over the soil's surface. Polyethylene sheeting that is 4- to 6-mil thick is acceptable.

Exterior Woodwork

Certain exterior woodwork is susceptible to decay, so pressure-treated wood should be used.

Door Frames

Door frames and jambs should not extend into or through concrete floors, especially exposed exterior doors. Door thresholds should not cover open-block or gaps in the footings.

Wooden Porches and Steps

Porch supports and piers that are adjacent to a building should be separated from the building by 2 inches to prevent hidden access by termites. Wooden steps should rest on a concrete base or apron that extends at least 6 inches above grade.

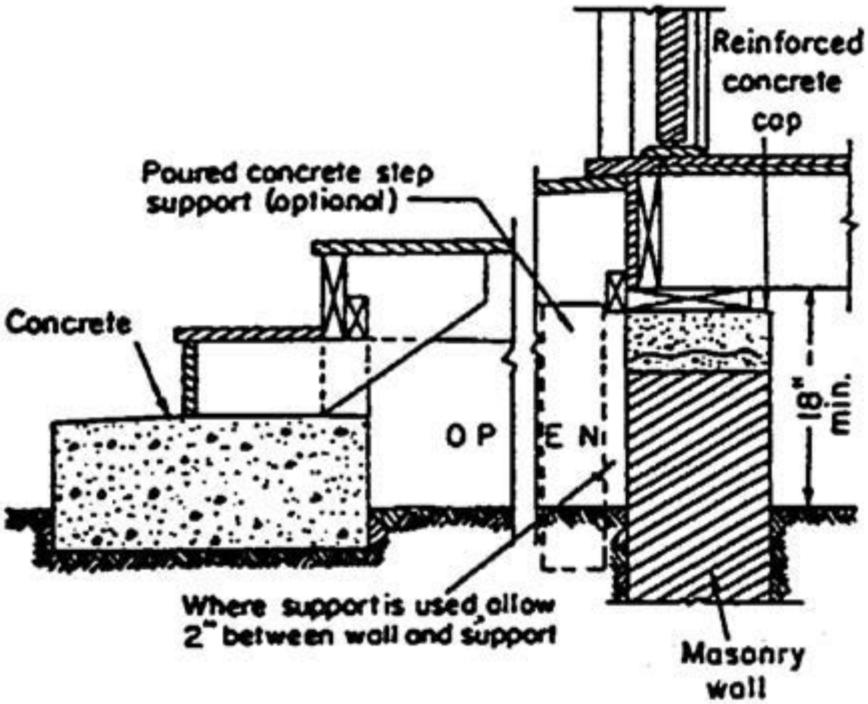


Figure 98. Proper construction of wooden steps of a porch to prevent hidden termite attack

Windows Below Grade

Where window frames and other openings near or below grade are made of wood, the foundation wall surrounding the wood should be made impervious to termites, and the level of the window well should be at least 6 inches below the nearest wood.

Skirting Between Foundation Piers

Where pier foundations are used, it is sometimes desirable to close the spaces between the piers with lattice or wooden skirting. If this is done, the woodwork should be separated from the piers and soil by at least 2 inches to allow for visual inspection.

WOOD USED IN BASEMENTS

Partitions and Posts

Wooden basement partitions, posts and stair carriages should be placed after the concrete floor is poured. They should never extend into or through the concrete; otherwise, they are more prone to attack and damage by termites. Reinforced concrete should be installed under them so that the concrete does not crack and allow termites access from the soil beneath. Concrete footings that extend about 3 inches above the floor level can be used under wood posts, stair carriages, heating units and other load-bearing points.

Basement Rooms

Termite infestation in basement rooms are very difficult to detect and control. Such situations commonly exist in recreation rooms and finished basements where untreated wood floors and furring strips are used. The best way to prevent these infestations is to treat the soil below the basement floor along the outside of the foundation, and in any voids that may exist in the wall. Because of the danger of decay, wood screens, sub-flooring and furring strips should be made from wood that has been pressure-treated with a wood preservative.

Girders, Sills and Joists

A building practice that causes concern is the placement of wooden girders, sills and joists in or on foundation walls in basements below the outside grade level. Termites may find hidden access to this wood; furthermore, the wood may be more subject to decay. Floor joists and girders boxed in masonry concrete walls should have an air space of at least 1 inch around the sides and ends. It is a good practice to use lumber impregnated with a preservative because it is difficult to remove these timbers once they are structurally damaged by termites.

Water Pipes and Conduits

In crawlspaces, all plumbing and electrical conduits should be kept clear of the ground. This can be accomplished by suspending them from girders and joists, where possible. They should not be supported by wooden blocks or stakes connected to the ground because termites can tunnel through these supports or construct tubes over them to the sills, floors and joists above. The soil around plumbing that extends from the ground to the wood above should be chemically treated.

Where pipes and steel columns penetrate concrete ground slabs and foundation walls, the spaces around them should be filled with dense cement mortar, roofing-grade coal-tar pitch, or rubberoid bituminous sealers after the soil around the pipe or column has been treated chemically.

Concrete Slab-on-Ground Construction

One of the most susceptible types of construction, and one that often gives a false sense of security, is the concrete slab on ground. Termites can gain access to the building over the edge of the slab or through expansion joints, openings around plumbing, and cracks in the slab. Infestations in buildings with this type of construction are the most difficult to control.

Because slab-on-ground construction is so susceptible to termite attack and infestations are very difficult to control in areas of termite activity, the soil should be treated with termiticides before pouring the concrete. Properly applied, such a treatment will protect a building for many years and is much less expensive than remedial treatments done at a later date. Foundations with sub-slab ductwork should be treated with extra care by an experienced technician.

Untreated wood, such as forms, scraps, grade stakes and wood plugs in or beneath the slab, should not be left in the construction area. The slab should be reinforced at all points where it is likely to crack.

Slabs vary in their susceptibility to penetration by termites. In order of degree of protection against termites, they are as follows.

1. A monolithic slab provides the best protection against termites. The floor and footing are poured in one continuous operation so that there are no joints or other structural features that might permit hidden entry to termites. The top of the slab should be at least 8 inches above grade. This type of slab is commonly used under sheds and garages.

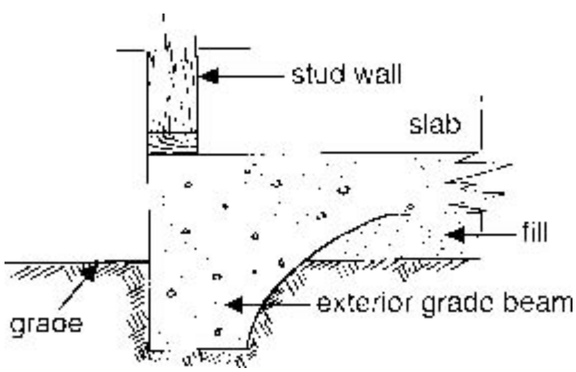


Figure 99. Monolithic concrete slab-on-ground construction

2. With a supported slab, the floor slab extends completely or partially across the top of the foundation. The slab and the foundation are constructed as independent units. A fully extended slab prevents hidden termite attack, even though a vertical crack may develop in the wall. Termites must still tunnel over an exposed part of the concrete slab. The top of the slab should be at least 8 inches above grade with its lower edge open to view.

3. The floating slab is in contact with the ground and is independent of the foundation. This is the most susceptible of the three types of slabs. It comes in contact with the foundation walls where there are expansion joints, through which termites may gain access to the woodwork above.

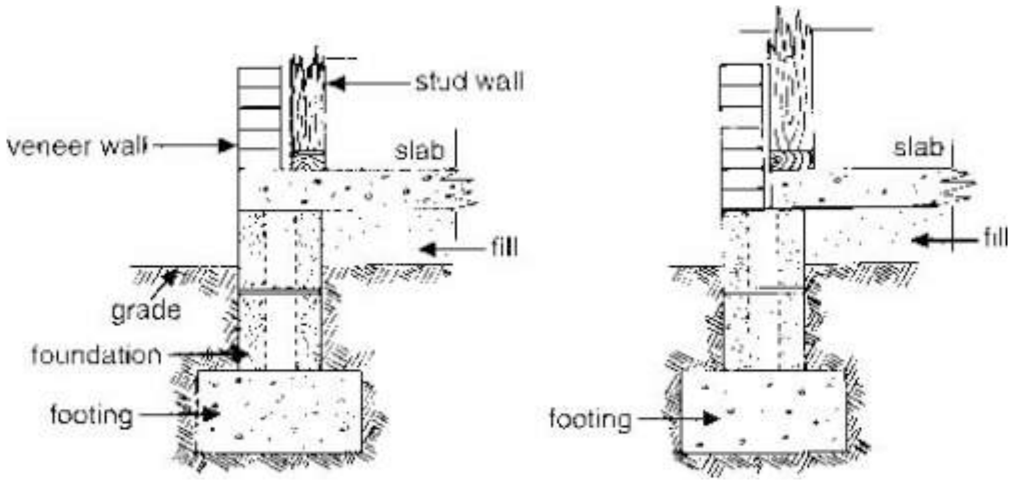


Figure 100. Supported concrete slab-on-ground construction

To reduce termite penetration through expansion joints and openings made for plumbing and conduits, they should be filled with roofing-grade coal-tar pitch or rubberoid bituminous sealers. However, this alone is not termite-proof. The soil should be treated with a long-lasting termiticide before the concrete is poured.

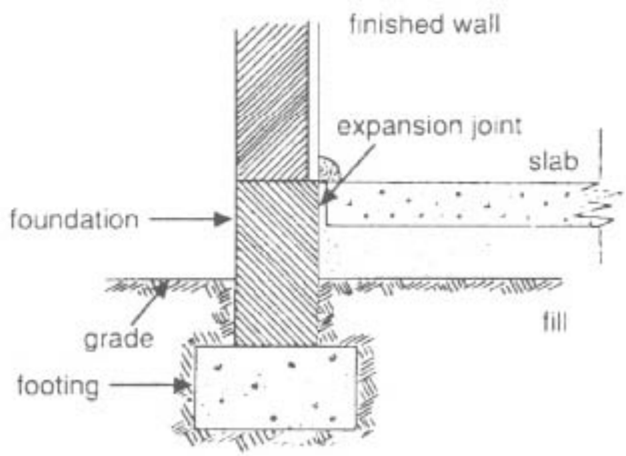


Figure 101. Floating concrete slab-on-ground construction

Chemically Treated Wood

Chemically treated wood resists attack by both termites and decay. The degree of protection depends on the kind of preservative, the penetration achieved, and the retention of the chemical in the wood.

Termites are usually able to build shelter tubes over any small barrier. This is often the case when they encounter naturally resistant wood or chemically treated wood. The termites construct tubes over the undesirable wood to attack the desirable parts. Only where drywood termites and decay are major concerns should chemically treated wood be used throughout a structure.

CHAPTER 16: WOOD-INHABITING FUNGI

Wood-inhabiting fungi is a group of lower plant forms that occur occasionally in many states of the U.S. They can cause severe problems in areas of high moisture or humidity. Wood-inhabiting fungi feed on both live and dead wood. They cannot make their own food. Some parts of fungi are so small that they can be seen only with a microscope. Other forms of fungi, such as mushrooms, are quite large. These fungi produce spores (similar to seeds) that are distributed by wind and water. Some spores are present wherever wood is being cut, processed or used.

Upon being infected by spores, the wood develops a fungus that forms microscopic, thread-like structures known as hyphae, which are referred to collectively as mycelium. The hyphae may spread through the wood in all directions from the point of infection both within the wood and on its surface.

All fungi that grow on wood have certain basic requirements, which include the following.

- The temperature range must be between 50º F and 100º F. The optimum is about 70º F to 85º F.
- The fungi cannot usually degrade wood that has a moisture content below 20%. Decay fungi require the wood to have a moisture content of about 30% in order to create serious damage.
- Fungi cannot live in water-saturated wood.
- Fungi require a food source.

Fungi are often found in structures in association with termites or in the same area as termites. Damage of fungi and termites commonly occurs together because the same environmental conditions favor the growth of both.

Since fungi may cause damage and may indicate the presence of termites, it is important to recognize and distinguish between the common types of fungi that attack wood. There are basically three types of fungi that attack wood. These include:

- surface fungi;

- staining fungi; and
- decay fungi.

Some fungi attack wood only in the log stage and cannot damage or continue developing after the wood is installed in a structure. No control is necessary for these fungi; however, it is important to recognize them as types that do not require control measures.

Surface Fungi

This group includes mold. Mold grows primarily in the sapwood of coniferous and deciduous trees. Wood with surface fungi has a powdery appearance and/or surface discoloration. These fungi do not cause wood decay. They grow only in the storage cells of sapwood and do not reduce the strength (other than impact strength) of the wood. Treatment is not required for wood that has been previously attacked by surface fungi and then installed in a structure.

Surface fungi are moisture indicators. Their presence suggests that the wood has absorbed an excessive amount of water and is susceptible to other wood-destroying fungi. They do not attack drywood, but they do increase the wood's permeability, or its ability to absorb moisture, which can lead to further decay.

Staining Fungi

This group of fungi also attacks the surface of the sapwood of various hardwoods and softwoods, but their hyphae penetrate the outer layers of the sapwood. These fungi cause a gray to bluish stain that cannot be removed from the wood. They do not cause decay, but they increase the chances that serious decay fungi will enter the wood. They enter wood cells and use the contents as a primary food source. The presence of these fungi also indicates that the wood has absorbed an excessive amount of moisture.

Decay Fungi

These fungi actually utilize the structural portion of the wood (its cell walls) to satisfy nutritive requirements. This results in decomposition, which makes the wood less suitable for construction purposes. If the decay caused by this fungi is advanced, the wood may be rendered completely unfit for use.

They attack the sapwood and heartwood. Chemical substances or enzymes secreted by the fungi break down cell wall components (cellulose, hemi-cellulose and lignin) to products that can be readily assimilated and utilized by the fungi.

Some types of decay fungi include:

- cubical brown rot: This rot causes the wood to break into small cubes, with cracks running perpendicular to the grain. This condition is caused by recurring changes in the moisture content from wet to dry. The wood becomes brittle and shrinkage occurs as a result of these moisture changes. The wood becomes brown and crumbly and its strength decreases rapidly. Cellulose is decomposed and lignin is left, which gives a brown appearance. Wood attacked by this type of fungi becomes brittle and can be crushed into a powder.

- white rot: Fungi that cause white rot attack not only cellulose but also lignin. Destruction of the lignin causes a whitish, bleached appearance. The wood becomes light-colored and stringy when broken. It has a sponge-like consistency, and the wood loses its strength gradually. White rot is common in crawlspaces that are continuously wet. Wood shrinkage is generally not associated with this type of rot.

- soft rot: Soft-rot fungi attack the wood from the surface inward, causing cavities to form. They are generally found in conditions where the wood is too wet to be attacked by other decay fungi. This type of rot might be found in cooling towers, pulpwood chips, marine habitats, and in wood in contact with soil. This rot is less destructive than white rot.

- dry rot: This is a type of brown-rot fungi and is referred to as a water-conducting fungus. This fungus has specialized structures called rhizomorphs that conduct water. Rhizomorphs begin to appear as attack by this fungus advances. This fungus is dirty white and becomes brown or black with age. It may range from 1/4-inch to 1 inch in diameter. Dry-rot fungus can attack wood that is resistant to attack by other decay fungi. In some cases, this fungus can conduct water up to 25 feet and destroy large areas of wood in one to two years. Mycelial fans that are papery in texture and whitish-yellow in color may be present.

Other Plant Growth Affecting Wood

Several other fungi attack wood before it reaches the lumber stage. Pecky rot and pock rot are two of these fungi. They may damage the wood, but they cannot develop inside a building. Bacteria can grow on wood that has a high moisture content. They are not destructive but can cause sour odors.

Control

All fungi that grow on wood have certain basic requirements that include a food source, a favorable temperature, and adequate oxygen and moisture. A deficiency in any of these requirements will inhibit the growth of a fungus even though it may already be well-established in the wood. The most practical method of controlling fungi in structures is to control the moisture content of the wood.

Methods of moisture control include:

1. isolating wood from soil;
2. installing moisture barriers;
3. providing adequate ventilation;
4. improving drainage; and
5. applying chemical wood preservatives.

The following checklist can be used as a guide in helping avoid problems with decay fungi and/or termites.

1. Soil from flowerbeds next to a house should not be in contact with any wood siding.

2. Soil should be properly graded. Wood should be at least 3 inches above the adjacent finish grade for framing members, and 6 inches above finish grade for siding.

3. Lawn sprinklers should be monitored. Persistent wetting of exterior wood creates a high decay hazard.

4. Wood junctions should be checked. Decay lurks especially where boards and beams are jointed together end to end. Also, the ends of boards and beams absorb water more readily than do the sides. Metal caps help prevent moisture entry and subsequent decay.

5. Ends of exposed beams can be problem areas. Cracks that open as the wood dries out permit the entry of rainwater. Exposed beams should be treated with a wood preservative. When thoroughly dry, the ends should be capped with a metal shield.

6. The roof overhang should be adequate to drain rainwater runoff away from the exterior walls.

7. Roof flashing between dormers and the chimney should be adequate for proper draining.

8. Roof lines should allow water to flow away from the house. Otherwise, the wooden members will be continually wet. Flashing should be properly installed to allow adequate drainage.

9. If shingles don't extend enough beyond the fascia board, water that enters under the shingles will drain over the wood trim at the roof edge. Metal edging creates a drip line that allows water from the roof to clear the wood trim.

10. Splashing rain can present another issue. Rain from the roof that falls onto a hard surface, such as a patio, can create unwanted splashing back onto the home's surfaces, so rain gutters with downspouts should be installed that direct roof drainage away from the house.

11. The surface areas of a porch must slope away from the house to avoid the formation of standing water and puddles.

12. Wooden posts should not touch the porch surface. Flowing water should be directed away from the posts.

13. Plumbing leaks should be repaired. These can occur behind the washing machine, dishwasher, at the top of a built-in tub, or in shower.

14. Condensation that forms underneath a house can create a host of problems. Some homes need a vapor barrier installed between the ground and the structure.

15. Water collecting under a house is a serious condition. Water should drain away from house.

CHAPTER 16: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

T/F: One important measure to use to prevent termite problems is to make sure that untreated wood does not come into direct contact with soil.

(●) True (correct)

( ) False

T/F: A poured concrete foundation, properly reinforced to prevent large shrinkage and settlement cracks, is the most resistant type of foundation to termite penetration.

False

True (correct)

The exterior siding should be at least _____ inches above the outside grade and should not extend down more than ___ inches below the top of the foundation walls, piers and concrete caps.

6..... 2 (correct)

12..... 24

24..... 12

2..... 6

T/F: Door frames and jambs may extend into or through concrete floors.

True

False (correct)

T/F: Fungi are often found in structures in association with carpenter bees or in the same area as bees because the same environmental conditions favor both.

False (correct)

True

T/F: Persistent wetting of exterior wood by lawn sprinklers creates a high potential for decay.

True (correct)

False

CHAPTER 17: UNDERSTANDING FOUNDATION STRUCTURES

The three basic foundation types are:

- slab-on-ground;
- crawlspace; and
- basement.

There are several types of slab-on-ground foundations, including monolithic slab, supported slab, and floating slab.

A plenum is a type of closed crawlspace construction.

Each foundation type is discussed in further detail in this section. A structure's susceptibility to termite attack is greatly influenced by the construction type(s) as well as by construction practices. Some types of construction are more prone to hidden termite infestations than others. Treatment procedures differ somewhat, depending on the foundation type.

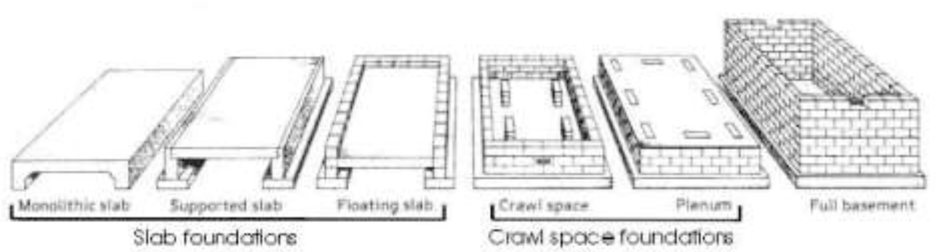


Figure 102. Foundation types (Handbook of Pest Control, 7th Edition, [original figure slightly modified])

Slab-on-Ground Foundation

Slab-on-ground construction is used extensively throughout the U.S. The three basic types of slab-on-ground foundations are:

- monolithic slab;
- supported slab; and
- floating slab.

These different types vary in their susceptibility to termite attack.

In monolithic slab construction, the concrete foundation footing and slab floor are formed as one continuous unit. A solid concrete foundation eliminates joints and other structural features that permit hidden termite entry. A monolithic slab typically provides the best protection against termites. However, the homeowner may have a false sense of security because many termite entry points are not readily visible.

Because termites have to come up over the solid concrete foundation and into the exterior block masonry to gain access to the structure, these sites are not the main source of termite problems in monolithic slabs. Problem areas are generally limited to the openings for pipes and plumbing, any faults and cracks in the slab, and grading stakes and other articles embedded in the slab. Termites might use these to gain access to the structure. Furthermore, termites can travel up the outside wall and behind an exterior veneer of brick, stone or stucco, particularly if the veneer extends below grade.

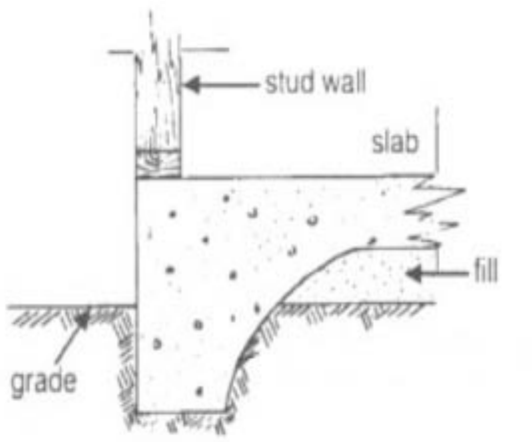


Figure 103. Monolithic slab foundation (illustration courtesy of MSUE)

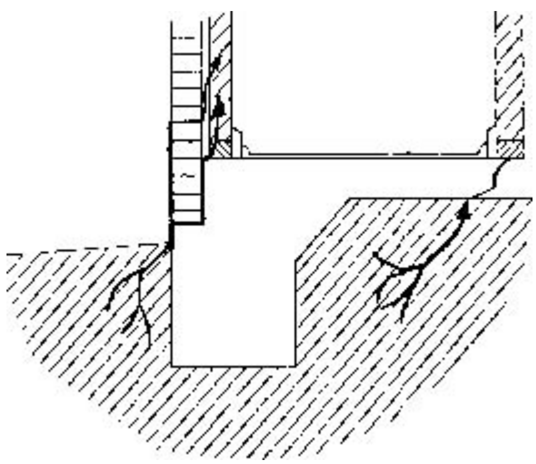


Figure 104. A monolithic slab foundation and a brick veneer with arrows indicating potential termite entry points into the structure (illustration courtesy of MSUE)

In supported slab construction, the slab floor and the foundation wall are separate units, with the slab floor extending over the top of the foundation wall which supports it. The slab floor is concrete; the foundation wall may be constructed from a variety of materials, such as solid block, hollow block or concrete.

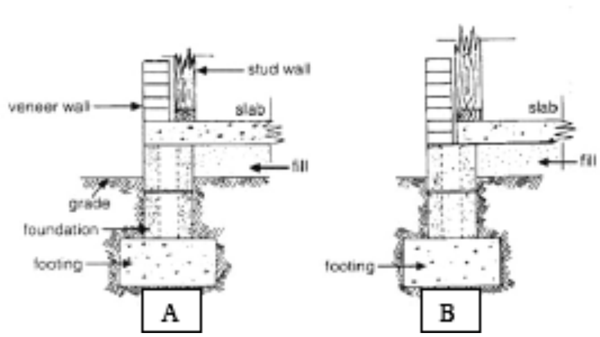


Figure 105. Supported slab construction shows the slab extending completely over the top of the foundation wall (A) and the slab resting on a portion of the foundation wall (B). (illustration courtesy of MSUE)

When the slab extends completely across the top of the foundation, the joint between the foundation wall and the slab is visible on the outside of the structure. It is important that the lower edge of the slab is not below grade and is kept open to view. Then, if a vertical crack develops in the masonry foundation wall, termites will have to tunnel over an exposed part of the concrete slab. Nevertheless, termites may enter a structure via any cracks that develop in the concrete slab, and their entry points may not be readily visible.

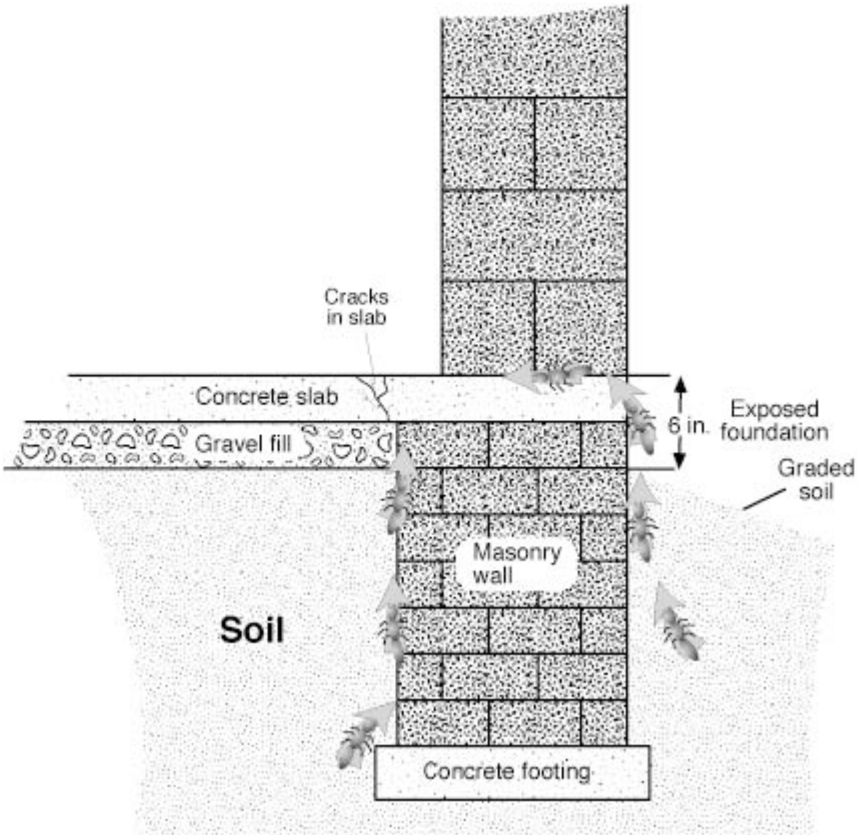


Figure 106. A structure with a supported slab foundation with arrows indicating potential termite entry points (illustration courtesy of the Ohio State University, Extension Entomology)

When the edge of the slab rests on the foundation wall, a hidden joint is created around the entire inner perimeter of the structure. This type of construction is highly susceptible to termites, and is similar to that observed for floating slab construction.

In floating slab construction (sometimes called suspended slab construction), the concrete slab floor and the foundation wall are separate units, with an expansion joint between them. The expansion joint is hidden by the interior floor covering.

The slab floor does not extend over the top of the foundation wall, but instead rests on the fill material. The foundation wall can be composed of a variety of materials, such as hollow concrete block, solid block or concrete.

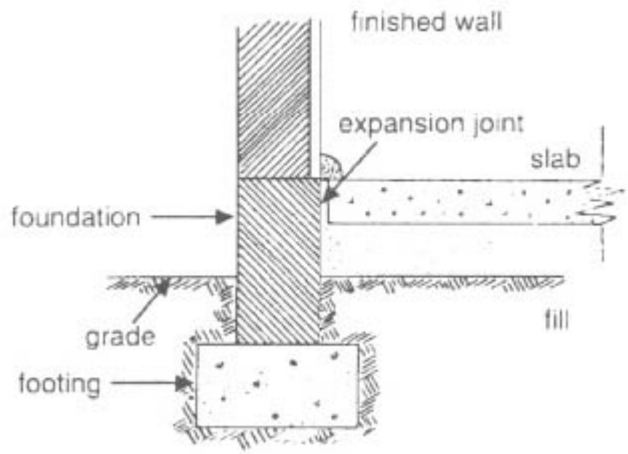


Figure 107. Floating slab construction (illustration courtesy of MSUE)

Floating slab construction is highly susceptible to termites, which may enter via several hidden routes. Termites can move from the sub-slab area up through the expansion joint between the concrete slab and the foundation wall, and then into the interior. They may proceed upward to feed on wood floors, door jambs, window frames, and even roof timbers. Termites also can gain access into the concrete block where it meets the footer, then travel upward inside the blocks' voids. This allows them access to nearly all of the wooden structural members in the house, as well as any framing and wooden trim. When the foundation is made of hollow concrete blocks, preventing termite entry through the center voids is a primary concern.

Another less common method of termite entry into floating slab construction is from the outside soil, up over the surface of the concrete block (via shelter tubes), and into a crack or void in the masonry. The termites can then move upward through the concrete block voids or into the furred wall. This is more common when there is an attached outside slab, such as a sidewalk or carport, that abuts the exterior structure, leaving an expansion joint as well as an unexposed, protected site for termite activity.

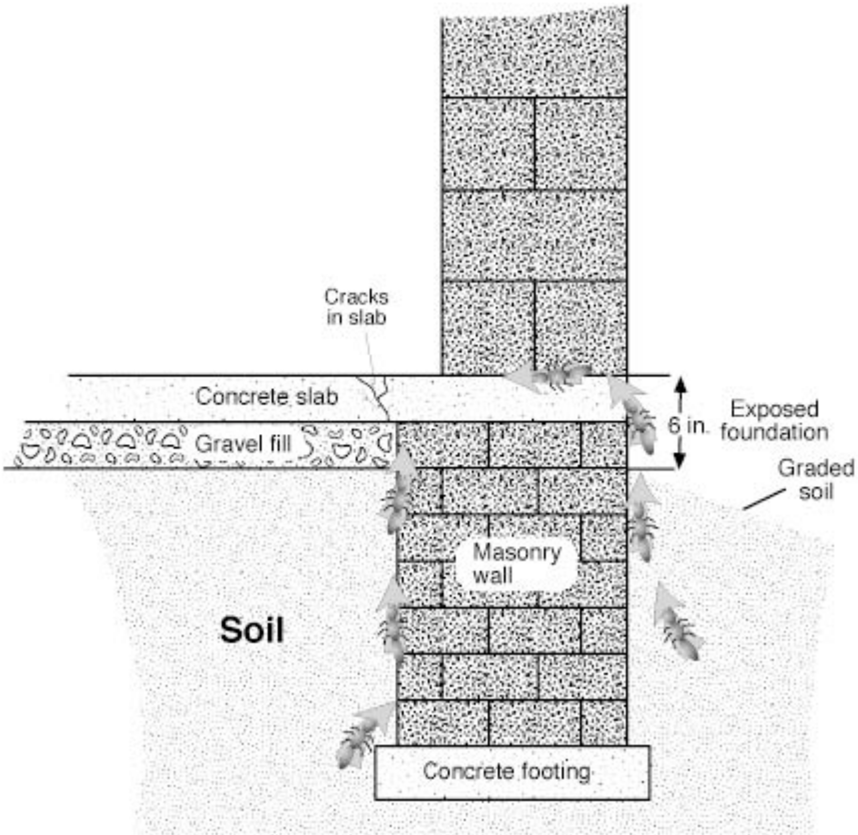


Figure 108. A structure with a floating slab and hollow concrete block foundation wall with arrows indicating potential termite entry points (illustration courtesy of MSUE)

Crawlspace Foundation

Crawlspace construction is common in many parts of the U.S. A crawlspace is an unfinished shallow space, usually less than 3 feet high, below the living quarters of a structure. This space is not livable or habitable. The floor of the crawlspace is typically exposed soil or gravel, although it occasionally is concrete. Masonry piers may be present inside the crawlspace. The crawlspace is usually enclosed by the foundation walls and may or may not be accessible to the inspector.

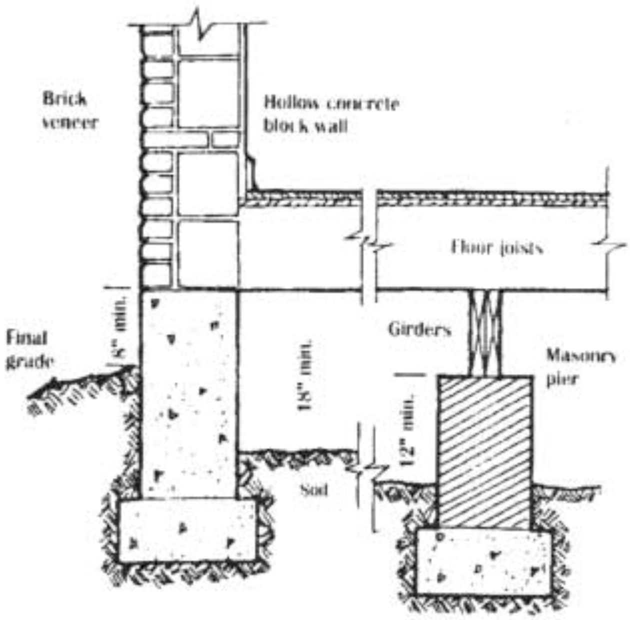


Figure 109. Crawlspace construction (illustration courtesy of MSUE)

Termite entry points into crawlspace construction are shown above. The exposed soil, the short distance to wooden floor joists and sills, the relative dampness, and the sheltered conditions are factors that make crawlspaces an ideal place for termites to find and infest wood. Crawlspaces also typically contain cellulose-based trash and debris that termites can feed upon.

Some buildings are constructed so that the crawlspace under the home is used as a plenum for air distribution. A plenum crawlspace requires specific insulation and air sealing so that it can be used for air distribution. The air from a central furnace is blown into the closed crawlspace and allowed to enter the living space via air registers cut into the floor. A potential drawback is that delivery of cool air to the crawlspace can lead to condensation of moisture from hot, humid outdoor air if it comes into contact with poorly insulated or sealed portions of the crawlspace. Inspection of a plenum crawlspace may be difficult or impossible due to accessibility issues.

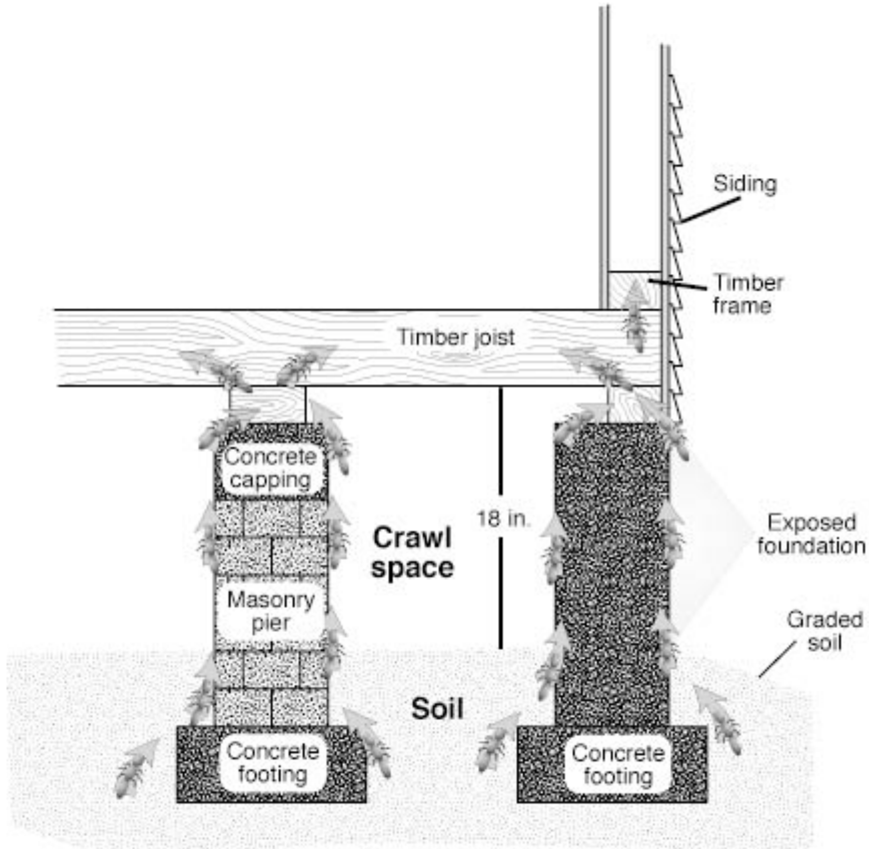


Figure 109a. Crawlspace construction with arrows indicating potential termite entry points (illustration courtesy of the Ohio State University Entomology Extension)

Basement Foundation

A basement is a habitable area either completely or partially below grade and beneath the main story of the home or structure. It may be either finished or unfinished: with or without wall and ceiling coverings. Finished basements have many inaccessible areas.

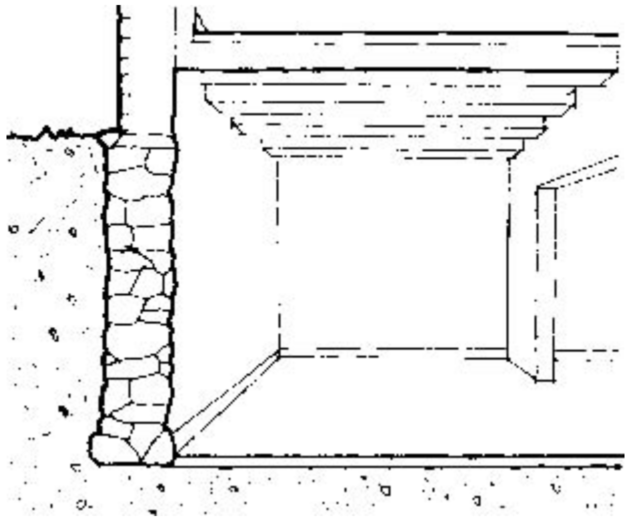


Figure 110. Basement construction (illustration courtesy of MSUE)

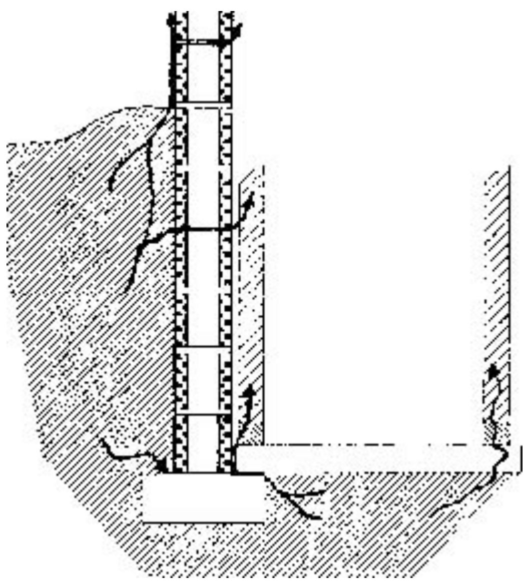


Figure 111. Basement construction with arrows indicating potential termite entry points (illustration courtesy of MSUE)

Basement construction is vulnerable to termites. Typical termite entry points into basements are shown above. Termites can enter a basement at the slab expansion joint where the floor and wall meet. Termites also can travel behind the brick veneer of a foundation wall. They may gain entry via cracks and holes in the concrete slab floor of the basement and via wooden support members that extend into the soil. It is important to remember that termites can enter through any crack or crevice as small as 1/32-inch.

CHAPTER 18: INSPECTION STRUCTURES

This section covers inspection of the following areas and components:

- the exterior of a structure;
- the interior of a substructure;
- crawlspaces;
- unfinished basements;
- finished basements;
- slabs (the area under the slab is understood to be inaccessible);
- the habitable areas of a structure; and
- attics.

This section is intended to give the inspector the basic principles for conducting a visual, diagnostic inspection for wood-destroying organisms (WDOs). In the course of a standard property inspection, an inspector is not required to report any conditions that are conducive to an insect infestation, according to the InterNACHI Standards of Practice for Inspecting Residential Properties and the International Standards of Practice for Inspecting Commercial Properties. However, this information is invaluable for the inspector to have in order to make knowledgeable decisions about where to inspect for suspected WDO activity.

The WDO inspection is intended to report any visible evidence of reportable insect infestations in or on the structures to be inspected. Live insects do not need to be present on or in the structure for the inspector to report the structure as infested. Evidence of termite activity may include mud shelter tubes, shed swarmer wings, or excavated wood. Carpenter ant activity may be determined from frass or excavated wood. Frass at exit holes in wood and loose frass may be evidence of powderpost beetles. Carpenter bee activity may be evident from round holes in fascia boards or deck rails and fecal material and dislodged pollen on the uppermost siding.

In addition to inspecting for wood-destroying insects, the inspector must look for signs of previous inspections or treatments. Inspection companies and pest management companies often place their printed stickers in areas that should be conspicuous to another inspector. Look for these stickers on electrical panels, furnaces, water heaters, stairway stringers, etc.

Evidence of previous treatment for wood-destroying insects may include drill holes in the foundation walls and slabs (sidewalks, porches, driveways, house and garage slabs) or termite bait stations. If the seller or agent is available, ask them if they know of any previous WDO treatments.

Scope of the Inspection

The inspection process begins with ordering of the inspection by a real estate agent, title company, mortgage company, buyer or seller. At the time of scheduling the inspection appointment, the inspector should find out what structures are involved in the transaction and need inspection, and the time frame for the inspection to take place and the report to be generated.

The WDO inspection should include the main structure(s), which usually includes a house and any attachments, such as additions, attached porches/decks, and attached garages, and any detached or outbuildings as requested by the person ordering the inspection and report.

Fence posts, mulch, stumps and wood piles on the property are not considered part of the structure to be inspected, according to the state-mandated NPMA-33 form guidelines. However, an inspection of these items will help the inspector determine whether wood-destroying insects are present nearby. Wood-destroying insects found in locations other than the actual structure may be reported in the comments section of the NPMA-33 form, but the inclusion of such comments is at the discretion of the inspector.

Termite-Detecting Dogs

The use of termite-detecting dogs is a great advance in inspection methods. Like their bomb- and narcotics-detecting counterparts, these dogs, usually beagles, are specially trained to use their highly developed sense of smell to help their handlers locate infestations of termites, wood-boring beetles, carpenter ants, and other live, wood-damaging insects. Inspectors can use information from these trained dogs to enhance their own visual and physical inspections.

Termite inspections using dogs cost $50 to $100 more than inspections performed by humans alone, but the cost is usually justified by the increase in thoroughness of the inspection and the added precision in pinpointing sites of infestation. This added precision can lead to enormous savings to the property owner by focusing treatment on the site of infestation, rather than on the entire building.

Inspection Equipment

Upon arriving at the property to be inspected, the inspector should have, as a minimum:

- a powerful flashlight (with extra batteries and bulbs or an extra flashlight);

- a probe (a flat-head screwdriver, awl, ice pick, or similar tool) for testing the integrity of wood in the structure;
- the NPMA-33 report form; and
- a pen and clipboard.

Other tools and equipment that are typically needed during an inspection for wood-destroying insects include:

- measuring tape;
- ladder;
- toolkit with screwdrivers, pliers, hammer, etc.;
- mirror;
- thin saw blade;
- moisture meter; and
- digital camera.

It's essential to have on hand the appropriate personal protective equipment (PPE) that includes:

- gloves;
- coveralls;
- bump hat/hard hat;
- knee pads; and
- dust mask.

Other items that may be helpful in certain circumstances include:

- borescope;
- termite detection dog;
- methane detector;
- stethoscope; and
- infrared camera.

Moisture Meters

A moisture meter will help determine whether the moisture content of the wood is high enough to support the growth of wood-inhabiting fungi, wood-boring beetles, or subterranean termites. The needles of the meter should be inserted along the grain of the wood to give the most accurate reading. Temperature corrections should be applied to readings taken below 70° F and above 90° F. Correction tables are supplied with the meters. The meters should not be used in wood that has been treated with water-borne wood preservatives or fire retardants.

Infrared Thermography

A thorough scan of an area suspected of being infested can be done with an infrared camera. This may reveal small but significant differences in temperature in different areas of a room. If the infrared scan uncovers a suspicious warm area or an anomaly that appears to be part of a pattern suggesting infestation (such as behind a section of wall, for example), further investigation will be needed.

INSPECTING THE EXTERIOR OF A STRUCTURE

At the exterior of a structure, the inspector should look for any wood-to-ground contact. In locations where the grade level or abutting slab is above the sill plate, termites do not even need to build mud tubes to get to the structure; thus, they may be hidden and difficult to detect. The inspector should look closely if this situation exists. The inspector should look for termite shelter tubes on the slab. The inspector should also look for any rigid foam insulation, particularly if it is in contact with the soil, as this can provide access and shelter for termites. It's also a favorable nesting site for carpenter ants. The inspector should also check areas next to and along the foundation to see if there are any old form boards, wooden stakes, or any cellulose-based materials that can provide a potential food source for termites.

When inspecting the exterior of the structure, some other areas that should be examined include:

- siding below grade or near grade;
- planter boxes;
- firewood piled against the structure;
- the garage door frame and other exterior door frames;
- carports;
- enclosed porches; and
- siding behind porch slabs.

Subterranean termites need moisture to survive. The inspector should pay attention to the soil grade to determine if it properly slopes away from the structure, as this affects moisture accumulation near the foundation. The inspector should carefully inspect areas that are damp or wet.

Some additional areas and components to inspect that may be sources of excess moisture include:

- air conditioners;
- leaky spigots;

- sprinkler systems;
- downspouts and gutters, particularly if improper drainage is evident;
- sump pumps;
- flat roofs;
- chimneys;
- dense vegetation growing against the foundation's walls; and
- thick mulch piled against the foundation's walls.

The inspector should check other potential areas for wood-destroying insect activity, such as:

- deteriorating or rotted window frames, door frames and siding;
- pipes and conduits that penetrate through the foundation walls;
- cracks in the foundation walls or slab;
- the joints where a foundation abuts an earth-filled porch; and
- fascia boards and siding.

The inspector should look for carpenter bee holes, fecal material, and dislodged pollen.

The exterior of the structure must be inspected for indications of carpenter ant activity. Some of the areas to examine include:

- utility wires and cables connected to the structure;
- trees touching the structure;
- attached fences;
- porches;
- roof overhangs;
- loose siding;
- any areas of the structure with evidence of moisture problems;
- firewood piled against the structure; and
- hollow structural columns.

Decks and porches are considered part of the structure if they are attached to the structure. Inspectors should carefully inspect and probe any areas that have wood-to-soil contact and look for evidence of termite activity. If the bottom of the floor joists is less than 18 inches from the ground, the area should be inspected as well as possible without entry under the deck, and this area should be reported as inaccessible on the NPMA-33 form.

Although decks are usually constructed with treated lumber, experience has shown that attacks by wood-destroying insects can still occur, especially on weathered wood. Carpenter ants commonly infest voids created between a deck and the main structure, as well as the voids of their hollow support columns.

The inspector also should pay attention to the shape or footprint of the foundation. It may be that some of the areas beneath the structure should be inspected (if accessible), but they may not be distinguishable and/or accessible from inside the structure. These may include newer additions to the original structure that may be constructed with a crawlspace or slab. A tape measure is useful to compare interior and exterior linear dimensions of the structure, which can reveal hidden or inaccessible areas.

There may be times when the inspector is unable to thoroughly inspect the exterior of a structure because of snow, ice or standing water, which may prevent access to areas normally inspected. Such conditions should be reported in detail on the inspection form (NPMA-33). It may be recommended that these areas be inspected at a later time when the weather conditions are favorable.

INSPECTING THE INTERIOR SUBSTRUCTURE

An area underneath a structure is one of four main types (but may also be a combination, depending on additions, etc.):

1. crawlspace;
2. unfinished basement;
3. finished basement; and/or
4. slab. The area under the slab is understood to be inaccessible.

Crawlspace Inspection

Crawlspaces may be accessible from either outside or inside the structure. Diligence is sometimes needed to locate the access to a crawlspace. Utility rooms and closet floors are common areas to look for an access door. Sometimes, they are accessible only from the exterior of the structure. A crawlspace opening that meets the dimensional requirements (at least 18 inches wide and 18 inches high) and can be reached using an 8-foot ladder is considered accessible.

If the entrance to the crawl space is less than 18 inches wide and 18 inches high, the crawlspace is considered inaccessible. Any areas determined to be inaccessible in a crawlspace must be reported as such on the NPMA-33 form. Any areas of the crawlspace that are less than 18 inches from the floor to the bottom of the floor joists are considered inaccessible.

Any areas covered with insulation and thus inaccessible for visual inspection must be reported as such on the inspection report form (NPMA-33) and/or its attachments.

The presence of some inaccessible areas does not negate the inspector's responsibility to visually inspect the remainder of the crawlspace that is accessible. There may be occasions when the crawlspace is obstructed or contains standing water so as to render it inaccessible. Unsafe conditions, such as broken glass, animals, faulty electrical wiring, etc. may also limit access. It may be recommended that the crawlspace be inspected at a later time when the obstructions or unsafe conditions have been removed. Once again, it is critical to provide proper, thorough and detailed documentation of these situations using the NPMA-33 form.

When inspecting a crawlspace, sufficient effort must be made to crawl to all accessible areas to visually inspect them. PPE, such as gloves, coveralls, a bump hat, kneepads and a dust mask, are particularly important for inspecting the crawlspace. An inspection should include the visually accessible sub-floor under kitchens and bathrooms where potential moisture problems may exist.

In crawlspaces, always inspect for direct evidence of wood-destroying insect activity, such as:

- termite shelter tubes on foundation walls, piers and wooden members;
- freestanding termite shelter tubes that are hanging down or coming up from soil;
- damaged wood;
- carpenter ant frass;
- live or dead insects or insect parts, such as termite wings. Note that insects are often caught in spiderwebs; and
- powderpost beetle exit holes and/or frass.

Conditions in crawlspaces that contribute directly to termite activity include:

- cellulose debris;
- wooden form boards and stakes left over from construction;
- cracks in the foundation;
- tree roots or stumps; and
- foam insulation along footers and foundation walls.

Moisture problems in crawlspaces are common. The inspector should recognize conditions that could lead to an insect infestation, such as:

- poor ventilation;
- puddles and standing water;
- plumbing leaks;
- inadequate grade level;
- cracked foundation walls;

- lack of a moisture barrier on the crawlspace floor;
- faulty downspouts and drainage; and
- insulation between floor joists and in the box sill.

INSPECTING AN UNFINISHED BASEMENT

Unfinished basements have no wall or ceiling coverings. They allow for a visual inspection of critical areas, such as the sill plate, box sill, and floor joists. In some situations, insulation may prevent a thorough examination of these areas.

Any areas that are covered with insulation and are thus inaccessible for visual inspection must be reported as such on the inspection report form (NPMA-33) and/or its attachments.

The inspector should also check the basement window frames for insect activity, particularly if the windowsills are below grade. Spiderwebs, particularly those near windows, should be examined for evidence of wood-destroying insect parts. Any utility lines coming through the foundation walls or basement floor should be examined. The furnace area should be inspected for signs of termite shelter tubes and termite swarmers.

INSPECTING A FINISHED BASEMENT

Finished basements pose a challenge for the WDO inspector. Many of the areas that are critical to inspect are covered with various materials that can hide evidence of insect activity. Even the bottom of the stair stringers may be hidden or inaccessible for visual inspection. If the ceiling covering is drywall or permanently attached acoustical tile, the area above or behind the ceiling is considered inaccessible for inspection and should be reported as such. Drop ceilings with tiles suspended in a support grid may be removable around the perimeter of the room to permit limited access to critical areas.

Although some suspended tiles may be removed at the inspector's discretion, this is still considered to be a very limited visual inspection, and any area with a drop ceiling should be reported as inaccessible, in accordance with NPMA directives based on HUD specifications.

It is common to encounter insulation in areas above dropped ceilings, which makes the area less accessible or totally inaccessible for inspection.
Conditions of inaccessibility created by the ceiling materials and/or insulation must be reported on the NPMA-33 form and/or its attachments.

INSPECTING A SLAB FOUNDATION

Note that the area under the slab is understood to be inaccessible. Termites can gain access to the structure through expansion joints, cracks in the slab, and openings around plumbing, so all of these areas require inspection. The accessible baseboards and door frames on slab construction should be tapped and inspected for insect activity or damage. Inspection should include areas around any plumbing pipes that come through the slab floor, as well as along seams in the floor. As previously noted, when conducting the exterior inspection, inspectors should look for evidence of shelter tubes on the outer edge of the slab.

INSPECTING THE LIVING AREAS OF A HOME

Inspectors should pay particular attention to bathrooms and kitchens, and inspect inside bath traps, if accessible. Inspectors should check around any pipes that come through the walls and floor and along the seams in the floor for signs of termite shelter tubes and evidence of termite swarmers. Accessible baseboards and door frames should be tapped and inspected for insect activity and damage. All windowsills should be inspected for evidence of deterioration from insect activity and for dead insects that were attracted to the outside light. The inspector should realize that, occasionally, cosmetic materials and/or stored items are used to cover evidence of insect activity and damage. Inspectors should carefully check any areas with new wallpaper, trim or paint.

INSPECTING ATTICS

Care and good judgment must be used by the inspector when entering an attic.

Attics without floors should be reported as inaccessible. Attics with no stairway or pull-down ladder should also be reported as inaccessible.

If the attic has a floor suitable for walking or crawling and has pull-down ladder or a stairway, that attic should be inspected. The inspector should examine the sheeting, rafters and eaves, if possible. Other areas include around pipes and chimneys where roof leaks might lead to an insect infestation.

If the attic is accessible, the inspector should also look for:

- termite shelter tubes;
- shed termite swarmer wings; and
- carpenter ants.

The attic typically contains insulation that limits or prevents the inspector from making a visual inspection of critical areas within. Such condition must be reported on the NPMA-33 form and its attachments.

CHAPTER 19: INSPECTION ITEMS

Inspectors and homeowners should check the following locations for structural decay and pest damage. This can be accomplished both visually and by probing with a pointed tool, such as an ice pick. As regular home maintenance and as part of an annual home maintenance or WDO inspection, homeowners and inspectors should check for signs of moisture, damaged wood, insect frass, and termites' earthen tunnels and/or fecal pellets.

ROOF: OVERHANGS, GUTTERS, EAVES, TRIM, ATTIC

Roof Surface

Inspectors who climb roofs should check the roof for cracks, missing shingles, and other openings where moisture might enter. Shingles should extend 3/4-inch or more beyond the edge of the roof and should form a continuous drip line at the eave and end rafters, or at the rake boards that cover the end rafters. Homeowners should perform regular maintenance by removing leaves from the roof surface, and replacing any missing shingles. They or their contractors should install flashing or an aluminum drip edge under the first course of shingles to divert rainwater from the fascia board and walls of the building. Care must be taken not to block eave vents. Flashing should curl over the forward edge of the fascia board about 2 inches and then run about 6 inches beyond a vertical line drawn from the inside face of the wall studs. Seasonal maintenance includes checking for the formation of masses of ice on the roof near the gutters, which can lead to water filtration and/or excessive condensation on interior attic walls.

Gutters

Homeowners and inspectors can check for poorly sloped, clogged, rotted or leaking gutters that can lead to leaks in the eaves, overhang, or siding. Leaves and twigs that absorb moisture and cause rot should be removed as part of regular home maintenance. Gutters should be hosed out prior to the rainy season. Leaf strainers and gutter guards can be installed to minimize maintenance.

Attics

Extra effort is needed to inspect areas that are difficult to see or reach. Inspectors should use a high-powered flashlight and a probe to search for rain seepage or decay around vents, pipes, antennae, wall top plates, skylights, and other penetrations.

Eaves, Overhangs and Fascia Boards

There should be at least 18 inches of overhang to allow proper rainwater runoff. Short overhangs should be extended. Inspectors should search for soft, tunneled, cracked or exposed areas. Inspectors should also examine areas where algae, moss or lichens are growing or where discoloration has occurred. These conditions indicate excessive moisture and potential fungus problems, as well as inviting habitats for termites.

Flashing

Areas around vents, chimneys and dormers should be flashed and their joints well-sealed. Rusty or broken nails can cause problems in flashing. Aluminum or galvanized nails are required to prevent electrolysis, which a chemical reaction between dissimilar metals that can cause the nails to disintegrate. Nail heads and flashing joints should be sealed with marine-quality caulk or silicone, (Tar preparations are the least expensive, but they crack after a few years in the sun.)

Damaged or Discolored areas

Inspectors should check for exposed areas that are soft, tunneled, cracked, rotted or blistered. They should also check for algae, moss, lichens or discoloration because these areas indicate potential breeding grounds for fungi and/or insects. The sources of excessive moisture should be located and promptly repaired.

EXTERIOR WALLS

The following problems discovered during an inspection should be addressed by the homeowner. Some repairs should be undertaken by a competent contractor.

Rusty Nails

Rusty nails and staining caused by rust indicate excess moisture within the wall and/or the use of non-galvanized nails. Nails and screws should be aluminum or galvanized.

Deteriorating Paint

Deteriorating paint is indicated by the loss of its sheen, bubbling and peeling. The surface should be scraped, sanded and repainted. If the wood seems soft or spongy, those areas should be thoroughly scraped out. If holes are smaller than 1/2-inch in diameter, they can be filled with caulk as an adequate repair. Larger holes can be filled with epoxy wood-filler. If holes are very large, the wood should be replaced.

Building Siding That is Stained or Buckled

Stained or buckled siding (with or without peeling paint) is a symptom of underlying moisture, rot or insect infestation. Splashing rain or lawn sprinklers can create excess moisture on the siding. If possible, the source of the moisture should be removed and the damaged wood removed and replaced. In tropical and subtropical areas and areas of heavy rainfall, such as Hawaii, the Northwest, and the Gulf Coast, pressure-treated siding is usually recommended. Other more durable materials that can be used include aluminum and vinyl siding. Pressure-treated woods are treated with toxic materials, so their use should be minimized.

Damaged Wood Junctions

Moisture and insect problems often occur where wood pieces join or abut, particularly when there is shrinkage, splintering or settling. Corners, edges of walls, roof-siding intersections, and siding-chimney contact points are particularly vulnerable. Water repellent and caulk should be applied to these joints. These areas should be monitored regularly for building movement.

Weathering of Exposed Lumber and Beam Ends

Expanded, split or cracked lumber ends provide access for moisture and insects. Even previously treated wood is subject to attack if the openings are deep enough. Cracks should be caulked and sealed and monitored for further developments.

Loose Stucco and Cracks in Stucco

The inspector and the homeowner should search for cracks, especially stress cracks around windows and doors. These conditions can provide access to moisture, termites, and decay organisms. Cracks should be caulked. If they are large, the old stucco should be replaced.

Moisture Accumulation Around Laundry Facilities

The inspector and the homeowner should check for signs of moisture accumulation around the vents of washing machine and clothes dryers. If necessary, the vents should be modified to direct exhaust air away from the building.

Moisture Associated with Pipes and Ducts

The inspector and the homeowner should check for moisture where ducts pass through wooden parts of a building. Downspouts should be observed during heavy rains for leakage and proper drainage. Homeowners should insulate ducts, install splash guards below downspouts, repair damaged downspouts, and direct water away from buildings.

Damp Window Sills, Windows and Doors

The inspector and the homeowner should check for cracked sills and casings, and poorly fitted windows and doors. Ill-fitting doors may indicate warping of the door or its casing from excessive moisture or uneven settling. Moisture problems can alter door jambs. Warped and cracked sills and poorly fitted windows and doors allow water access to the structural members, which aids in decay and provides an initial insect habitat. Cracks should be caulked and monitored for further development. Warped door thresholds and jambs may need replacement, and casings may need repair if the cracks are too large to caulk effectively.

FOUNDATION AND GRADE

Soil Surface

The soil surface should slope away from the building in order to carry water away from the foundation. Seepage under the foundation will cause it to crack and settle. Fill can be added to direct water away from the building. There should be at least 8 inches between the top of the fill and the sill. If adequate clearance is not possible using fill, foundation gutters, splash blocks and/or perforated pipe can be installed instead. Their performance should be checked during rains or the system can be tested with a hose. A sump pump can also be used to move water away from the foundation.

Low Foundation Walls and Footings

Wooden components should be at least 8 inches above the soil surface. Low foundation walls or footings often permit wooden structural members to come into contact with the soil, which provides access for subterranean termites. These areas should be repaired; alternatively, sub-grade concrete gutters can be installed where the building sills sit too close to ground level. Wood that comes into contact with the soil should be removed and replaced with concrete, if possible.

Foundation Cracks

Cracks in the foundation can allow decay organisms access to wood. Cracking may also indicate uneven settling. Cracked walls should be monitored for discoloration and seepage during rains. Termites use cracks to gain access to wood hidden from view. If the problem is serious, the foundation may need repair.

Brick Veneer and Stucco at the Foundation

The bond between the veneer or stucco and the foundation wall should be checked. If it is failing, moisture and termites may have a hidden entrance to wooden portions of the building. The loose covering should be removed to explore the extent of any decay.

CRAWLSPACE, BASEMENT AND FOUNDATION

Enclosed crawlspaces should be vented to allow moist air to escape. Milder climates are especially vulnerable to dry-rot fungus. In humid climates, the sub-floor can become wet from condensation from interior air conditioning. Shrubbery or other obstacles that block air flow through foundation vents can cause the air underneath the building to stay warm and moist, which is an ideal environment for termites. Existing vents should be cleared of dust, plants and debris. Foundation vent openings should equal 2 square feet of opening for each 25 linear feet of exterior wall. An opening should be installed within 5 feet of each corner. More vents can be installed, if needed. The top edge of the concrete under all vents should be at least 6 inches above the finished grade to allow for sufficient ventilation. Vents located below grade may require wells to prevent surface water from entering sub-floor and basement areas. Roof drainage should be diverted away from vents.

Corners of the Building

The inspector and the homeowner should check for moisture accumulation and stains at junctions of wood surfaces in these areas. Additional cellar or crawlspace vents can be installed to alleviate such problems.

Enclosed Areas

Proper ventilation is important under staircases, porches and other enclosed areas because these areas are vulnerable to moisture accumulation. Decayed, discolored and stained areas are telltale signs of problems. Venting should be added or adjusted.

Vapor Barriers

Condensation on the sub-floor and/or sill may indicate the need for a vapor barrier at the sub-floor and on the soil surface in the crawlspace. A vapor barrier can be installed to reduce the moisture resulting from poor soil grading, unexpected seepage, or high rainfall. The crawlspace's soil surface should be covered with a 6-mil polyethylene vapor barrier. Roofing paper should not be used for this application because it can rot. A slurry of concrete can be placed over the plastic to protect it from rodents. Where condensation continues to accumulate, installing extra vents or electric-powered vents whose fans and openings are operated automatically may solve the problem. A sump pump can be installed to remove standing water.

Wood-to-Stone and Wood-to-Concrete Contact

The inspector and the homeowner can check to see whether the wood is pressure-treated by looking for perforation marks from the chemical injections on the surface of the wood. Untreated wood should be replaced with rot-resistant or pressure-treated wood. Sealing material should be applied between the wood and stone or concrete, with metal washers should be placed between posts and footings.

Leaky Pipes and Faucets

Even small leaks can keep the wood or soil underneath it continuously moist, thereby setting up ideal conditions for termites. Areas where rain splashes on walls should be protected with rain guards. Sprinklers should not be allowed to spray the side of the building. All leaks should be fixed, and irrigation practices should be altered, where necessary.

Water Heaters and Space Heaters

Heaters in dirt-floor crawlspaces or basements are not recommended. If the soil near the pilot flame is kept warm throughout the year due to lack of insulation, microbial and insect development will be accelerated. The heater should be insulated and the soil should be covered over with concrete.

Paper Collars Around Pipes

Since paper is almost pure cellulose, it is extremely attractive to termites as a food source and should be removed and replaced with other insulting materials not capable of being eaten by termites.

Miscellaneous Openings

Meter boxes, inspection doors for plumbing fixtures, pet doors, milk delivery doors, and air exhaust vents should be checked for water access, cracks, termite pellets, and soft and deteriorated areas.

EXTERIOR AREAS

Porches

The inspector and the homeowner can check for wooden steps in contact with soil, which can lead to decay and termite access. The porch surface must slope away from the building to carry rainwater away quickly. If the porch does not slope away from the building, the siding should be checked for moisture and termites.

Tongue-and-groove flooring is a water trap. If there is a space between the porch and the building, this area should be checked for drainage problems. Cracks should be caulked and repaired. Spaces between tongue-and-groove floorboards should be filled with caulk or resurfaced and refinished with wood-sealing compounds and appropriate paint. Another floor can be installed over the original if the additional weight can be properly supported from below.

For earth-filled porches, the soil should be at least 8 inches (optimally, 12 to 18 inches) below the level of any wooden members. Excess soil should be removed, where possible, and the area should be regraded to enhance drainage. The porch can also be redesigned to eliminate earth-wood contact.

Planter Boxes

Planter boxes that are built against a structure can allow termites direct access to unprotected veneer, siding, and cracked stucco. One remedy is to add a 2- to 3-inch protective concrete wall between the planter and the building. An air space several inches wide must separate the planter wall from the building and must be kept free of dirt and other debris.

Trellises and Fences

Wooden portions of a trellis that touches the soil and is connected to a house can provide a direct link to a building for wood rot and termites. Fence stringers and posts should be checked for decay. If found, the decayed portions should be removed. A concrete footing can be installed for trellises and fence posts. Decayed stringers can be replaced, leaving a small gap between the stringers to allow for air circulation. Wood and concrete should be separated using metal washers.

Wooden Forms Around Drains

These are sometimes left in place after the concrete foundation is poured but they can provide termites with access routes to inner walls. Areas and joints around pipes rising from slabs should be sealed with tar or another adhesive to prevent water and termite access. The holes should be caulked and monitored for decay and excess moisture.

Gate Posts, Fence Tie-ins, Abutments and Columns

These can be inspected for weakness and rot, especially around areas adjacent to the soil. Exposed areas can provide cracks for termite invasion. If wooden posts go through concrete into the soil below, they should be checked for evidence of termite attack. The bottoms of these posts should be cut and replaced with a concrete footing. The tops of posts should be cut at an angle to promote rainwater runoff and prevent water from penetrating the vulnerable end grain.

Balconies and Landings

Surfaces should be sloped away from the building. The junctions at the floor and siding should be checked for moisture and insects intrusion.

Wood Debris Under and Around Buildings

Pieces of wood, particularly partially buried tree roots or construction lumber, can help support a termite colony until the population grows large enough to attack the building itself. Since cardboard boxes are very attractive to termites, they should be removed from crawlspaces and basements with earthen floors and disposed of properly.

INTERIOR LOCATIONS

Areas with water stains or active mold growth indicate excessive moisture and should be analyzed for corrective action. Special attention should be given to the areas listed below.

Kitchen Plumbing Pipes

Homeowners and inspectors should check for condensation and leaks, especially where pipes enter walls. Leaks should be repaired and pipes should be insulated where condensation is excessive.

Counter Areas

Areas around and below sinks should be checked for moisture and decay. Wall surfaces should be caulked or otherwise protected from moisture. Sub-surface areas damaged by water leaking from above may be tolerated if the surface leaks are repaired.

Exhaust Vents

Interior vent leaks originating from the exterior should be repaired with caulk or water-resistant sealing material, or the vent should be replaced, along with any rotted wood around it. Extra flashing can be used to fill any gaps.

Toilets

The integrity of the floor around each toilet base can be checked by thumping it lightly with a hammer. The wax seal should be checked for leakage at the floor-toilet pedestal intersection. The wax seal should be replaced, if necessary. The cellar or crawlspace below the toilets should be checked for any leakage or moisture-related damage, which should be promptly repaired.

Showers and Sinks

All sinks and showers should be checked for a sound caulk seal. Splash-over on the floors from inadequate water barriers or carelessness by residents can lead to moisture-related damage. If moisture is visible from the crawlspace, it may indicate a crack in the floor or in drainage pipes. If moisture is visible in the ceiling, it may indicate cracks in the delivery pipes.

Damaged flooring materials, pipes, drains and sink basins should be replaced, if necessary. Sealing compounds may be useful when leaks are relatively recent and small, especially if termites have not been found; however, regular monitoring is necessary if sealing materials are used.

Tile Walls

The homeowner or inspector should check for mildew stains. The grout used on tile walls should have a silicone coating to prevent water penetration. Walls should be cleaned regularly to remove mildew and improve ventilation.

Ceilings

Blistered areas can indicate moisture leaks in the area above the ceiling, or inadequate installation of a vapor barrier. Leaks and faulty vapor barriers should be repaired.

Windows

Windows should be checked for moisture accumulation and/or water stains on frames, sills and walls. Homeowners and inspectors can search for evidence of decay or insect attack next to window glass where condensation accumulates, at edges where moldings meet walls and casings, and in window channels and door jambs. Gaps between window and door casings may be avenues for hidden moisture and insect access. Homeowners and inspectors can check interior walls beneath windows, especially if they are regularly wetted by garden sprinklers. Windows should be opened, when practical, to improve air circulation. Double- or triple-glazed windows should be selected when window replacement becomes necessary. Aluminum frames are a better alternative if wooden frames are decayed. Lawn sprinklers should be moved so that water does not hit windows.

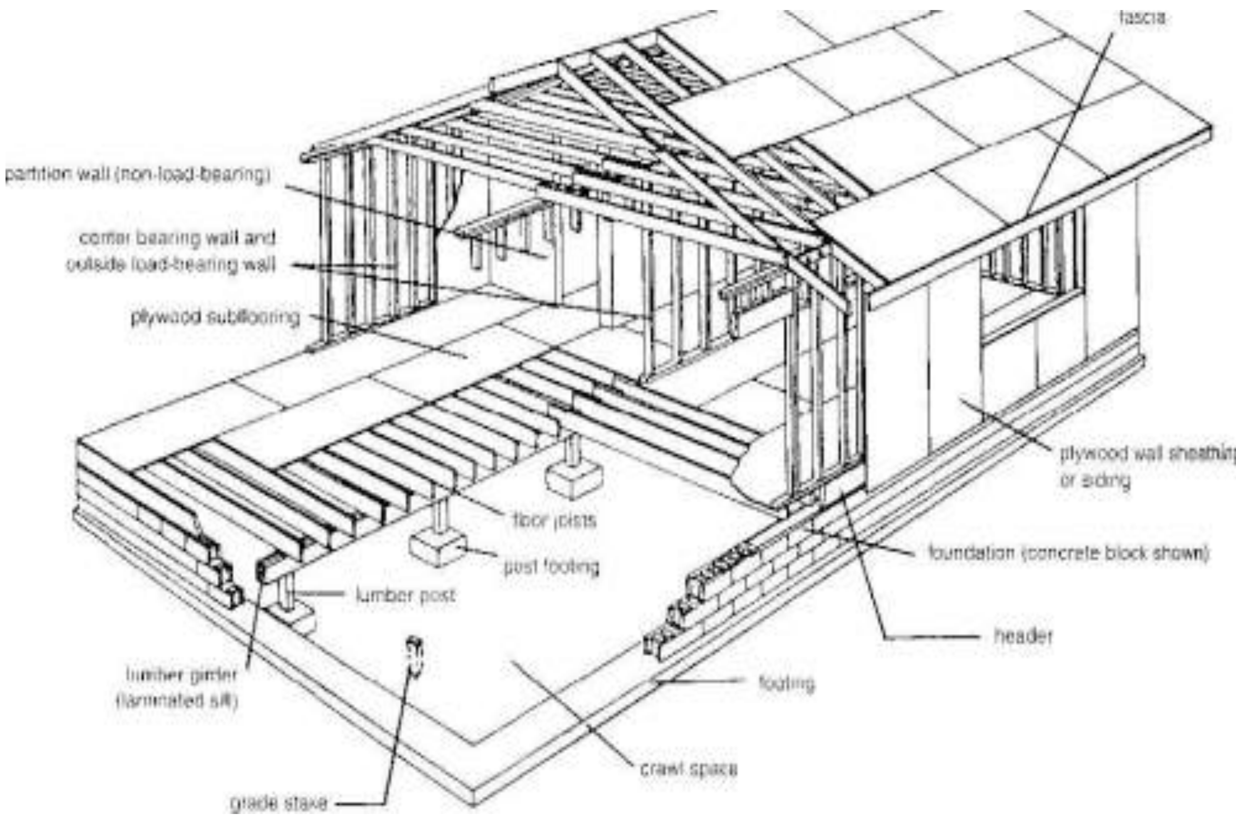
Closets

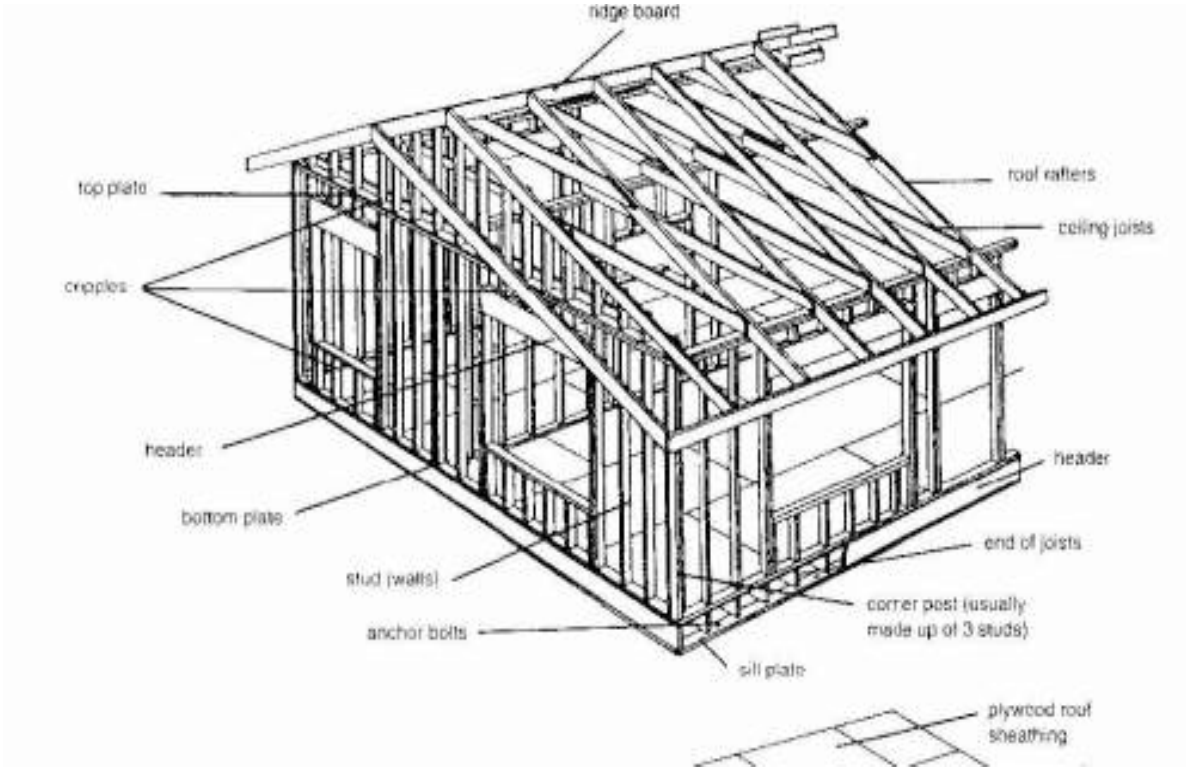
Coat and storage closets should be checked for dampness. A light bulb left burning continuously in a damp closet will often generate enough heat to dry it out, but care should be taken to make sure the bulb is far enough away from stored materials to avoid creating a fire hazard. Containers of highly absorbent silica gel, activated alumina, or calcium chloride also remove moisture from the air in enclosed spaces. These agents should be placed out of reach to avoid accidental exposure. The use of silica gel should be avoided where children may tamper with the containers. These chemicals can be re-used after drying them in the oven. Small exhaust fans can also improve closet ventilation.

Floors

Sagging or buckling floors may indicate shrinkage or rot from excessive condensation or water leaks. Gaps between floor and baseboards may indicate wood damage from insects, fungi, or water-triggered swelling and shrinkage.

DIAGRAMS IDENTIFYING STRUCTURAL MEMBERS

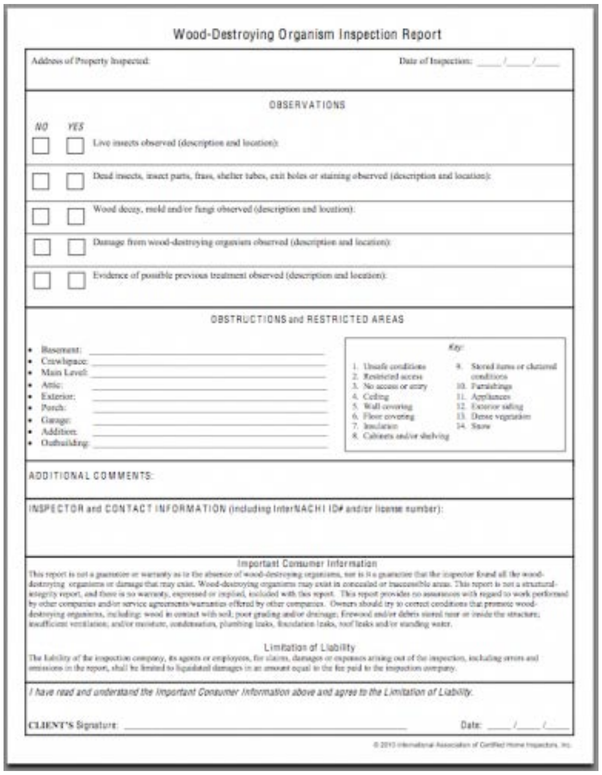




WOOD-DESTROYING ORGANISM INSPECTION FORM

Download the InterNACHI WDO Inspection Form

http://www.nachi.org/wdo-report.htm



Wood-Destroying Organism Inspection Report

Address of Property Inspected: Date of Inspection: ____/____/____

OBSERVATIONS

NO YES

☐ ☐ Live insects observed (description and location):

☐ ☐ Dead insects, insect parts, frass, shelter tubes, exit holes or staining observed (description and location):

☐ ☐ Wood decay, mold and/or fungi observed (description and location):

☐ ☐ Damage from wood-destroying organism observed (description and location):

☐ ☐ Evidence of possible previous treatment observed (description and location):

OBSTRUCTIONS and RESTRICTED AREAS

- Basement:
- Crawlspace:
- Main Level:
- Attic:
- Exterior:
- Porch:
- Garage:
- Addition:
- Outbuilding:

Key:

1. Unsafe conditions
2. Restricted access
3. No access or entry
4. Ceiling
5. Wall covering
6. Floor covering
7. Insulation
8. Cabinets and/or shelving
9. Stored items or cluttered conditions
10. Furnishings
11. Appliances
12. Exterior siding
13. Dense vegetation
14. Snow

ADDITIONAL COMMENTS:

INSPECTOR and CONTACT INFORMATION (including InterNACHI ID# and/or license number):

Important Consumer Information

This report is not a guarantee or warranty as to the absence of wood-destroying organisms, nor is it a guarantee that the inspector found all the wood-destroying organisms or damage that may exist. Wood-destroying organisms may exist in concealed or inaccessible areas. This report is not a structural-integrity report, and there is no warranty, expressed or implied, included with this report. This report provides no assurances with regard to work performed by other companies and/or service agreements/warranties offered by other companies. Owners should try to correct conditions that promote wood-destroying organisms, including: wood in contact with soil; poor grading and/or drainage; firewood and/or debris stored near or inside the structure; insufficient ventilation; and/or moisture, condensation, plumbing leaks, foundation leaks, roof leaks and/or standing water.

Limitation of Liability

The liability of the inspection company, its agents or employees, for claims, damages or expenses arising out of the inspection, including errors and omissions in the report, shall be limited to liquidated damages in an amount equal to the fee paid to the inspection company.

I have read and understand the Important Consumer Information above and agree to the Limitation of Liability.

CLIENT'S Signature: Date: ____/____/____

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CHAPTER 20: BASIC CONSTRUCTION TERMINOLOGY

The WDO inspector needs to be familiar with the different elements of a structure. When reporting the results of an inspection, the WDO inspector must communicate his/her findings using standard terminology that describes the common aspects of the structure. Although the WDO inspector is not required to report conditions that may be conducive to pests, the inspector must be able to recognize those areas of a structure that are most likely to harbor an insect infestation.

The WDO inspector should be knowledgeable about current building methods, technologies and materials, as any of these factors may affect the inspection process. As construction practices change, so should the approach of the inspector. It is a good idea to periodically stop by construction sites to see what a structure looks like during the various stages of construction. Some construction types and practices are problematic because they lend themselves to termite infestation by providing ready or undetectable access.

This section provides definitions of common construction terms, as well as a basic overview of the foundation types and other elements of a structure. This section also discusses typical termite entry points found in various types of construction.

The WDO inspector should be familiar with the following terms:

- **attic:** the space above the ceiling floor and below the roofing material. This area may contain insulation, mechanical equipment and/or stored items. Access to roof rafters and roof sheathing is gained in the attic area. The attic may or may not be accessible to the inspector.

- **backfill:** the gravel or excavated earth replaced into the trench around and against a basement foundation

- **band board:** another name for header joist when fastened to the end of floor joists

- **basement:** a habitable area either completely or partially below grade and beneath the main story of the home or structure

- **bearing wall:** a wall that supports any vertical load in addition to its own weight

- **block wall caps:** solid masonry blocks that sit on top of hollow-block walls of a foundation

- **box sill:** area where the sill plate, floor joist and header joist meet

- **brick foundation:** a building foundation formed of bricks that are stacked in a staggered arrangement and held together with mortar. Brick foundations can be two, three, four, five or even more layers wide; the spaces/joints between these layers and the mortar can allow access to termites.
- **brick veneer:** a facing of brick laid against and fastened to the sheathing of a frame wall or tile wall construction

- **ceiling joists** or **roof joists:** one of a series of parallel framing members (usually wooden) used to support ceiling loads; ceiling joists are supported, in turn, by larger beams, girders or bearing walls. Insulation is often present between ceiling joists, especially in unfinished attics and other unheated areas.

- **concrete block foundation:** a building foundation formed of concrete blocks (usually 8x8x16) that are stacked in a staggered arrangement and held together with mortar. Termites may construct shelter tubes inside the hollow blocks and gain hidden access to the structure.

- **crawlspace:** a shallow, unfinished space beneath the living quarters of a structure. The floor of the crawlspace is typically soil or gravel but may be concrete. The crawlspace is not livable or habitable. The crawlspace is enclosed by the foundation walls and may or may not be accessible to the inspector.

- **cripple stud:** short vertical structural member (usually wooden or metal) used above and/or below windows and doorways. Cripple studs connect the sole plate to the bottom of the window sill.

- **decay:** disintegration of wood or other substance through the action of fungi

- **deck:** a floor-like platform, often made of wood, that is attached to a structure and typically used as an outdoor entertainment area

- **downspout:** a pipe, usually made of metal, for carrying rainwater from roof gutters and directed away from the structure

- **drywall:** interior wall covering material, such as plywood or gypsum board, that is applied in panels or large sheets

- **eaves:** the lower part of the roof projecting beyond the exterior walls

- **EIFS (exterior insulation and finish system):** EIFS consists of a Styrofoam® base that is applied to the exterior walls of a structure and then covered with a synthetic stucco material. EIFS is commonly referred to as synthetic stucco, and it is used in modern construction. Moisture problems often are associated with this type of material, which can provide conditions conducive to termite and carpenter ant infestations. EIFS is particularly susceptible to termites when it extends into the soil; termites readily tunnel through the insulation itself.

- **expansion joint:** a space between concrete components that allows for normal expansion and contraction. This space is commonly filled with a pliable material. Termites may find their way into a structure through these gaps in the concrete.

- **fascia:** horizontal boards attached to rafter/truss ends at the roof eaves and along gables. Gutters are typically attached to the fascia. Fascia boards are commonly attacked by carpenter bees.

- **flashing:** non-corrosive sheet metal or other material used around protrusions, angles (changes in roof pitch) and junctions in roofs and exterior walls to protect against water seepage

- **floor joist:** one of a series of parallel members (usually wooden) used to support floor loads. The floor joists sit on edge on top of the sill plate and are covered by the sub-floor.

- **footing** or **footer:** a masonry section, usually concrete, in a rectangular form wider than the bottom of the foundation wall or pier that it supports. The concrete footer sits or bears weight upon compacted soil and/or gravel. Footings must be placed below the frost line to prevent movement and protect their integrity.

- **form:** temporary structure erected to contain concrete during placement and initial hardening. Wooden form boards should be removed after concrete has set up; form boards that are left in place can be readily infested by termites.

- **foundation:** refers to the lower parts of the walls on which the structure is built. Masonry foundation walls are mainly below ground level.

- **foundation/sill plate insulation** (also called **tar board**): primarily installed as an insulation layer between the concrete foundation wall and wood sill plate. Termites will not eat or damage this but they may build shelter tubes over it or around it. Occasionally, Celotex® (a brand-name cellulose material) is used and can be eaten and damaged by termites and carpenter ants. The material manufactured today that is used for foundation/sill plate insulation is a thin and light plastic foam material. Termites do not feed on it, but they can penetrate through it.

- **frost line:** the depth of frost penetration in local soil

- **furring strips:** small strips of wood or metal attached to masonry walls that allow for a wall covering to be attached

- **grade:** the inclination or slope of the ground at the exterior of a structure

- **gradient:** the degree of the angle of the grade. A negative gradient that moves away from the structure is needed to be sure that water drains away from the foundation.

- **grain:** the direction, size, arrangement, appearance and/or quality of the fibers in wood

- **grout:** mortar that is of a consistency that it flows into the joints and cavities of masonry work and fills them completely

- **header:** 1) a beam placed perpendicular to joists to which the joists are nailed in framing for a chimney, stairway or other opening; 2) a wood lintel; 3) the horizontal structural member over a door or window opening

- **header joists:** horizontal boards that are fastened to the end of the floor joists to provide stability and to close off the voids between the floor joists to the exterior

- **joist:** one of a series of parallel members (usually wooden) used to support floor and ceiling loads

- **lintel:** the top piece over a door or window that supports the walls above the opening

- **masonry:** stone, brick, concrete, hollow-block, concrete block, gypsum block, and other similar building units and materials (or a combination thereof) that are bonded together with mortar to form a wall, pier, buttress or similar mass

- **mortar:** a mixture of cement (or lime) with sand and water that is used in masonry work

- **pier foundation:** a type of foundation that uses masonry or wood columns to support the floor joists or floor girders of a structure. This type of construction generally allows more access to termites.

- **plenum**: an enclosure in which the pressure of the air is greater than that of the exterior

- **plywood:** a panel of wood made of three or more layers of veneer that are compressed and joined with glue

- **porch (veranda, portico):** an open or enclosed gallery or room attached to the outside of a building at an entrance. Porches often harbor termites because they allow for moisture due to leaks and condensation.

- **pier-supported porch:** a porch that is constructed of concrete or wood and supported by a frame on top of piers, usually at two corners of the porch (but possibly all four), and then attached to the structure. The area under this type of porch may be a crawlspace.

- **slab-on-grade porch:** a concrete slab poured directly on the soil (or gravel) without a foundation. The area under this porch is inaccessible.
- **supported-slab porch:** a porch with a foundation (usually brick, concrete block or poured concrete) that supports a concrete slab. The area under this type of porch may be a hollow crawlspace, either accessible or inaccessible. If the area is filled with soil and/or gravel, it is considered inaccessible.

- **poured foundation:** a concrete foundation constructed in place with the use of forms to mold poured concrete into solid walls

- **rafter:** one of a series of structural members (usually 2x10s or 2x12s) installed on edge and at a pronounced slope to form and support the roof. The rafters of a flat roof are sometimes called roof joists.

- **rubble foundation:** a foundation constructed from field stones. This type of construction is usually found only in older homes. Many irregular voids are created, and these can provide multiple pathways for termites and/or moisture to enter the structure.

- **sheathing:** the structural covering (usually plywood, wafer board or particleboard) used over studs, floor joists or rafters/trusses of a structure

- **sill:** 1) the bottom framing member (usually a 2x4 or 2x6) resting on the foundation wall and supporting the floor joists. The sill is usually bolted with anchor bolts to the foundation wall; 2) the member forming the lower side of an opening, such as a door sill or window sill

- **sill plate:** the bottom horizontal member of an exterior wall frame resting on top of the foundation wall and usually anchored to it. The sill plate is typically treated lumber.

- **sole plate:** the bottom horizontal member (usually a 2x4) of an interior wall frame (either a load-bearing or non-load-bearing wall). Wall and partition studs rest on and are supported by the sole plate.

- **splash block:** a small masonry block laid on the ground to receive roof drainage from downspouts and to carry it away from the structure

- **stair stringers:** angled structural elements that support the stair treads (steps) and the risers (the backs of the steps). In basement construction, the base of stringers is sometimes embedded in the concrete slab.

- **stoop:** one or two steps of wood or concrete leading into a structure (house or porch) and positioned directly against the structure

- **stucco:** a plaster material, usually made with Portland cement or synthetic compound as its base, that provides a decorative and functional exterior wall covering
- **stud:** one of a series of vertical structural members (usually wood or metal) placed as supporting elements in walls and partitions. Studs are commonly covered by drywall or other finished material on the interior, and by sheeting or other weather-resistant material on the exterior.

- **sub-floor:** boards or plywood installed directly on the floor joists, over which a finish floor is laid; support posts; metal or wooden posts or columns that support floor joists from the crawlspace, basement or porch overhangs

- **terrazzo tile:** high-quality flooring consisting of white or colored grout with ornamental stones divided into sections with brass strips and ground to a smooth finish

- **threshold:** a strip of wood or metal with beveled edges used over the sill of a doorway or entryway

- **tile block foundation:** a building foundation formed from hollow ceramic tiles that are stacked in a staggered arrangement and held together with mortar. These hollow blocks can allow access to the structure by termites.

- **trimmer stud:** the vertical structural member (usually wooden or metal) that supports a header at a door, window or other opening

- **vapor barrier:** a material, commonly polyethylene sheeting, used to retard the movement of water vapor into walls, floors and slabs to prevent condensation from forming on them; a covering used over the soil/gravel floor of a crawlspace. A vapor barrier may be incorporated into the insulation, it may be attached to studs or the foundation walls, or it may be positioned under the concrete slab or on top of the crawlspace floor.

- **wood foundation:** a type of foundation whose footings, studs, and other components are composed of preservative-treated lumber and/or plywood. Wood foundations present a variety of concerns and problems related to inspecting and treating for wood-destroying insects.

CHAPTER 20: QUIZ

Please review your answers below. Any questions that you answered incorrectly can be changed and the quiz can be resubmitted as many times as you like.

A ________ is a material, commonly polyethylene sheeting, used to retard the movement of water vapor into walls, floors and slabs to prevent condensation from forming on them.

- (●) vapor barrier (correct)
- ( ) concrete cover
- ( ) floor protector
- ( ) big piece of plastic

Typically made of treated lumber, a ________ is the bottom horizontal member of an exterior wall frame that rests on top of the foundation wall and is usually anchored to it.

- ( ) girder
- ( ) top plate
- ( ) window sill plate
- ( ) saucer
- (●) sill plate (correct)

A slab-on-grade _________ is a concrete slab poured directly on the soil (or gravel), without a foundation, whose area underneath is typically inaccessible.

- ( ) roof
- ( ) deck
- (●) porch (correct)

The _________ is the depth of frost penetration in the local soil.

- (•) frost line (correct)
- ( ) hard ground
- ( ) freeze cutoff
- ( ) ice line

A ______ stud is a short, vertical structural member (usually wooden or metal) that is used above and/or below windows and doorways.

- ( ) box
- ( ) corner
- ( ) small
- (•) cripple (correct)

Another name for a header joist when it's fastened to the end of floor joists is a __________.

- (•) band board (correct)
- ( ) plate
- ( ) common band
- ( ) stud
- ( ) rafter

CHAPTER 21: LAWS CONCERNING WDI

LAWS CONCERNING THE CONTROL OF WOOD-DESTROYING INSECTS (WDI)

After successfully completing this section, you should:

- Understand why protecting the public and the environment from pesticide exposure is the applicator's responsibility.
- Know the role of an applicator working in the pest-control industry.
- Understand the various state and federal laws that govern pesticide use, handling and storage.
- Be able to explain the legal responsibilities of a pesticide applicator.

- Be able to describe the elements that should be included in the basic training of a pest-control applicator.

Pest management can be complex. It is a matter of using the right technologies and their special equipment and safety measures. To be successful, pest control must be effective and not adversely affect people or the environment. The number and variety of pesticides has increased, and pest management professionals need to know more about their safety and proper use. For these reasons many state and federal laws and regulations have been adopted to help protect the public, the environment, and the pesticide handlers themselves from the possible adverse effects caused by pesticide use. In this section, you will learn about the state and federal laws that regulate pesticide applicators, particularly commercial pesticide applicators.

Certified commercial applicators are responsible for pest management in and around structures that include homes, schools, hospitals, businesses, warehouses, etc. It is important that pest management professionals (PMPs) understand and keep up to date with the laws that affect pesticide application inside and around buildings. Ignorance of the law is never an acceptable excuse for a violation.

Protection: The Applicator's Responsibility

The responsibility for protecting the environment from the possible adverse effects of pesticide use ultimately rests with the pesticide applicator. Preserving the biological diversity of our planet by protecting the environment contributes to our overall quality of life. Each plant and animal is part of a complex food chain; break one of the links and the others are adversely affected.
Pest management technicians may see their normal work as unlikely to affect the environment, but spills and leaks during mixing, loading and transporting or incorrect disposal can lead to contamination of the groundwater or surface water, or the pesticide may invade the habitat of non-target organisms.

Pest management professionals often service national parks, schools, and other sensitive public areas. Category 10b Professionals have an even greater responsibility to the public because they often work in or around buildings where there is an increased risk of exposing people to pesticides.

All efforts should be made to achieve pest management goals through the minimal use of pesticides in and around buildings. When pesticides are used, they should be applied in a manner that will prevent human contact.

More Than Just Pesticide Application

To control pests, PMPs engage in many activities in addition to actual pesticide application. These other practices increase the effectiveness of the control program and often reduce the need for pesticide use, or make such use a secondary operation of the program.

An important area addressed throughout this course is communication. Pest management is a service; as such, customer service is key. Pest management professionals must not only know how to perform their jobs but also be able to communicate effectively with their clients. The PMP should be able to explain the basic procedures to the client's satisfaction. The client should feel confident that the PMP is able to meet his/her pest control needs safely and effectively. Also, the state of Ohio, for example, requires that certain information must be communicated to the customer (see the Ohio Pesticide Law).

State and Federal Laws

The "Applying Pesticides Correctly Bulletin" (Y25) discusses federal and state laws that govern the handling and use of pesticides. WDO inspectors should review the core manual and understand how various laws and regulations affect pesticide practices and use. These laws include federal laws, such as the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Occupational Safety and Health Act (OSHA), and the Endangered Species Act.

These are just some of the laws that affect commercial pesticide applicators. They are briefly described below. Pest management professionals should keep updated copies of the laws on hand and review their contents periodically. Copies of these laws can be obtained from county extension offices.

FEDERAL LAWS

FIFRA

FIFRA is the basic federal law administered through the U.S. Environmental Protection Agency (EPA) that regulates pesticides and their use, handling, storage, transportation, sale, disposal, etc. FIFRA defines a pesticide as a substance or mixture of substances intended to kill, repel or mitigate a pest. The Ohio Department of Agriculture (ODA) has a cooperative agreement with the EPA to enforce some provisions of FIFRA in that state. Some of the provisions of FIFRA are that all pesticides must be registered with the EPA before they can be sold or used. The pesticides must be classified as either for general use or restricted use.

General-use pesticides are those that anyone can purchase without restriction. Restricted-use pesticides can be used only by or under the direct supervision of a certified applicator. FIFRA also stipulates that persons who misuse pesticides (in a manner that is “inconsistent with the pesticide labeling”) are subject to penalties.

The Endangered Species Act

This act requires the EPA to ensure that endangered or threatened plant and animal species are protected from pesticides. This act requires each pesticide label to limit its use in areas where these species could be harmed. Category 10b Applicators must consider the possibility that endangered or threatened species may be affected by pesticides applied in and around buildings. The Ohio Department of Natural Resources (ODNR) Division of Wildlife administers the Ohio Endangered Species Act (Title XV, Chapter 1518, Endangered Species General Provisions) and maintains the federal and state Endangered or Threatened Species Lists. Michigan applicators who want to be sure that they are complying with the Act must take the initiative and consult with the ODNR to be sure that there are no endangered or threatened species in their area. One of the goals of pest management is to protect non-target plants and animals from pesticides, whether they are endangered or not.

OSHA

OSHA is subject to oversight by the U.S. Department of Labor (DOL). OSHA governs the record-keeping and reporting requirements of all work-related deaths, injuries and illnesses of businesses with 10 or more employees.

Summary

Many state and federal laws are designed to protect the public and the environment from the improper use of pesticides. It is the pest control technician's responsibility to understand and comply with these laws. Commercial pest management professionals often apply pesticides in public areas. All PMPs must be particularly careful to prevent contact between people and pesticides. Pest management professionals should be trained in IPM and other methods that limit the use of pesticides while still achieving pest management goals. Proper communication, notification, representation and record-keeping are essential whenever pesticides are used.

CHAPTER 22: TRAINING AND LICENSING

TRAINING AND LICENSING REQUIREMENTS

This section details the requirements and the processes necessary to become licensed to conduct WDO inspections for real estate transactions, including obtaining a commercial applicator/WDO inspector license, obtaining a pesticide applicator business license, and maintaining these Licenses.

A. Commercial Applicator License

All individuals who intend to conduct WDO inspections are required in many states to obtain a Commercial Applicator (CA) license. This license is required before individuals can perform WDO inspections.

The steps to obtaining a license include the following steps:

1. File a Pesticide License Application.

   The first step in the licensing process is to complete your state's Pesticide License Application. This application initiates the licensing process and provides the Department of Agriculture in your state with all of the necessary contact information for you and your business. The application typically allows applicants to request study materials for the categories(s) for which they wish to become licensed. Following receipt of the application and payment, category-specific study material is sent to the applicant.

2. Pay the Commercial Applicator license fee.

   This fee may vary by state.

3. Attend the mandatory WDO Diagnostic Training.

   All individuals who desire to become licensed to conduct WDO inspections are often required by their state to complete a mandatory training program.

4. Pass the exams.

   Once an applicant has received and reviewed their state's core and WDO category study materials and attended any mandatory training programs, s/he should be adequately prepared to take their state's certification exams. To become licensed to conduct WDO inspections, applicants are typically required to pass both a Core and a Category exam. If applicants want to become licensed to apply pesticides for the control of wood-destroying insects, licensure in additional categories may be required. Usually, categories can be added to existing licenses at any time at no additional charge.

B. Business License

In general, businesses with individual employees who perform WDO inspections are required to maintain a current Pesticide Application Business License (PABL).

To obtain a PABL, the following requirements must be met:

1. File a Business License Application.

2. Pay the Business License fee.

3. Provide proof of Errors & Omissions Insurance.

   Businesses are required to carry E&O insurance for the license to be issued and remain valid. An Errors & Omissions policy typically has a minimum limit of $50,000 per occurrence and a $100,000 aggregate limit.

C. Maintaining Your License

Once you have obtained your Commercial Applicator's license and Business license, various requirements must be fulfilled on an ongoing basis to keep these licenses active.

1. Annual License Renewal: Inspectors are required to renew their Commercial Applicator and Pesticide Application Business Licenses annually.

2. Re-Certification: All Commercial Applicator licensees are assigned a three-year period during which to fulfill their re-certification/Continuing Education requirements. The state's Department of Agriculture may require each licensed WDO inspector to complete five hours of re-certification every three years, for example. These hours may include Core training and Category-specific training. License-holders who do not complete the required CE hours during their licensing period are usually required to re-test.

CHAPTER 23: THE REAL ESTATE TRANSACTION

This section deals with understanding the real estate transaction from a WDO inspector's perspective, including the other parties to the transaction, and responsibilities of those parties.

The parties involved in a real estate transaction typically include:

- buyers;
- sellers;
- real estate brokers/agents for buyers, sellers or both;
- inspectors, such as the WDO inspector, gas line inspector, home inspector;
- the mortgage company;
- the real estate appraiser;
- the title company;
- the homeowners insurance company/agent;
- the attorney for the buyers and sellers; and
- governmental agencies, such as HUD, FHA/VA, zoning officials, and others.

Buyers are considered to be persons or an entity purchasing the subject real estate property. The buyer is expected to negotiate in good faith and to provide accurate information to other parties, such as mortgage companies, real estate brokers and agents, and any government agencies. In some real estate transactions, buyers are not directly represented by a broker, agent or attorney. However, it is becoming more common for buyers to be represented in the negotiations and at closing by an attorney and buyers' brokers and/or agencies. The buyer may or may not be a qualified expert on houses, real estate, or certain conditions or risks related to a real estate purchase transaction; thus, the level to which they rely on information provided by the other parties in the real estate transaction can vary. That's why it's crucial for the WDO inspector to clearly and fully disclose all pertinent information discovered during his/her visual inspection. As instructed by the NPMA-33 form, the buyer is to sign the form “as acknowledgment of receipt of a copy of the report.”

Sellers are generally represented by a broker and/or listing agent. Sellers are also expected to negotiate and act in good faith and to provide adequate and accurate information to the parties involved. Sellers must complete a Seller Disclosure Form in which the seller discloses and reports material information about the property, such as roof leaks, drainage problems, structural problems/defects, and past or current WDO infestations and/or treatments. These seller disclosure statements may be of value to the WDO inspector prior to the inspection, and may be requested from the seller and/or seller's broker/agent before the property is inspected. Some WDO inspection firms have their own Seller Disclosure Forms that must be completed prior to the inspection, and some require a personal interview with the seller.

The NPMA-33 form instructs the seller to sign the form, which commits the seller to asserting that all known property history and information regarding WDO infestation, damage from infestation, and treatment have been disclosed to the buyer. Real estate brokers and/or agents represent the interests of the party they have contracted to represent and have a duty to those parties. Brokers/agents commonly handle many or all of the details in negotiating and finalizing the real estate purchase contract, and the actions, services and inspections that are necessary to get the transaction ready to close, including, in many cases, ordering the WDO inspection and report on behalf of the party they represent.

Mortgage companies and lenders are those entities that provide financing for the purchase of real estate. Since these firms are providing the financing, they have a vested interest in the condition of the subject property in all aspects, including the condition of and reporting of the WDO inspection. Title companies are involved in the transaction to review the title of subject property to ensure it is clear of liens and legal claims and eligible for transfer of ownership. Title companies will usually perform the closing of the sales transaction.

While there are variations in the wording of real estate purchase contracts, most generally refer to an "Inspection or Inspections" section wherein they state: "The Seller shall, at Seller's expense, have the property inspected for WDO by a qualified inspector and furnish a report of the findings."

Some contract variations include:

- The WDO report is to be on an approved form, such as the NPMA-33, which is the current form approved by HUD, the FHA and the VA.
- Such inspection is to be performed by a state-licensed applicator.

Most real estate purchase purchase contracts state language similar to the following:

> "Buyer, at Buyer's expense, shall have ___ days after acceptance hereof to have the property inspected for WDO, and furnish a report on an FHA/VA-approved form by a Certified Pest (Termite) Control Applicator, and to secure a gas line warranty with a written guarantee from a gas line repair company or licensed plumber of Buyer's choosing. Seller shall pay Buyer, at closing, for the first $______ of the cost of such inspection and gas line warranty."

The real estate purchase contract provides the directive and, therefore, the requirement for a WDO inspection and report. Additionally, the U.S. Department of Housing and Urban Development (HUD) requires WDO inspections and reports on a HUD-approved form for any property for which HUD provides funding or guarantees for funding through private sources.

The WDO inspector is not a direct party as a signatory to the real estate purchase contract, but the WDO inspector can be construed as a party to the contract as implied by the nature of the contract to which the Buyer and Seller have agreed, in writing, as to the property to be purchased (and sold), the specific provisions and considerations (costs), and the expectations of the parties as to the services to be performed by the WDO inspector regarding any infestation(s) noted, based on a careful and professional visual inspection of the areas that were open and accessible for visual inspection within or on the structure(s) listed in the real estate contract on the day that the inspection was performed.

The purpose of the WDO inspection and report in a real estate transaction is to provide the parties with a factual report of the inspector's observations as to the presence or absence of visible evidence of WDO, damage due to any such infestation, and recommendation(s) for treatment(s) necessary for control of any infestation(s) noted, based on a careful and professional visual inspection of the areas that were open and accessible for visual inspection within or on the structure(s) listed on the real estate contract on the day that the inspection was performed. The inspector shall follow the instructions for properly completing the NPMA-33 form.
When a WDO inspection report is required for an existing property whose owners are seeking FHA mortgage insurance:

- The National Pest Management Association form NPMA-33: Wood-Destroying Insect Inspection Report must be completed. If the property is located in a state having a mandated wood infestation form, then the state-mandated form must be used. At this time, the following states have their own mandated form for wood-destroying insect infestation and the use of the NPMA-33 is not required: Alabama, Arizona, California, Florida, Georgia, Hawaii, Louisiana, Maryland, Mississippi, Nevada, North Carolina, Oklahoma, South Carolina and Texas.

- When a WDO report is required, all improvements within the property lines must be inspected and be free of active infestation. The validity period is 90 days from the initial date of inspection. (The use of a bait/monitoring system is acceptable when used in conjunction with an applied liquid chemical treatment.)

An inspection for WDO, which is requested as part of a real estate purchase contract, inherently involves many parties. Each party has their own interests, but all persons involved have responsibilities to several of the other parties.

CHAPTER 24: COMPLETING THE NPMA-33 FORM

Reporting the Results of an Inspection: Guidelines for Completing the NPMA-33 Form

Certified inspectors and commercial applicators conducting wood-destroying insect diagnostic inspections shall:

A. conduct all inspections in accordance with the practices set forth the state's wood-destroying insect diagnostic inspection training program, or other similar training programs, such as this course;

B. make a complete record of the findings of each inspection on an NPMA-33 form. In the event of conflicting instructions for completing the form, the provisions of any state law or regulation shall apply for all inspections made within the inspector's state;

C. completely and accurately record all of the following information in Section 1 of the form:

   1. the name, address and phone number of the pesticide business conducting the inspection;
   2. the license number of the pesticide business or registered location conducting the inspection;
   3. the date of the inspection;
   4. the physical address of the property inspected;
   5. the name, license number and original signature of the commercial applicator conducting the inspection; and
   6. the specific structures inspected.

D. record the following in Section 2 of the form for inspection findings on or within the specific structures inspected by:

   1. checking Box A if there is no visible evidence of wood-destroying insect activity;
   2. checking Box B if there is visible evidence of insects observed; and

      a. if live insects are observed:

         i. check Box B(1);
         ii. list the types of insects observed; and
         iii. state the specific location (including, by way of example, but not limited to: sill plates, foundation, etc.) where the insects are observed.

      b. if dead insects, insect parts, frass, shelter tubes, exit holes, staining or other physical evidence are observed:

         i. check Box B(2);
         ii. describe the type of insects and insect parts observed, and describe all other physical indicators observed, including, but not limited to: frass, shelter tubes, exit holes and staining; and
         iii. state the specific location (including, by way of example, but not limited to: sill plates, foundations, etc.) where the dead insects, insect parts, frass, shelter tubes, exit holes, staining or other physical indicators are observed.

c. if visible insect damage to the structure are observed:

   i. check Box 3;
   ii. describe the type of damage observed; and
   iii. state the specific location (including, by way of example, but not limited to: sill plates, foundations, etc.) where the dead insects, insect parts, frass, shelter tubes, exit holes, staining or other physical indicators are observed.

3. checking “yes” or “no” in response to the question of whether evidence of previous treatment was observed. If evidence of previous treatment is observed (including, but not limited to: drill marks, bait stations, dyed wood from borate treatments, or dusted carpenter bee holes), or if documentation was supplied to the inspector prior to the inspection, the commercial applicator conducting the inspection shall check "yes" and:

   a. describe the evidence of previous treatment;
   b. state the specific location (including, by way of example, but not limited to: sill plates, foundation, etc.) where the evidence of previous treatment is observed or documented; and
   c. attach to the form copies of any documentation supplied.

This box shall be checked regardless of whether Box A or Box B in Section 2 of the form is checked.

If the comments to be noted in this section of the form exceed the space provided, the commercial applicator conducting the inspection shall attach supplemental pages to the form, and state in Section 5 of the form that additional pages are attached to the form.

E. in Section 3 of the form, check one box in accordance with the following:

   1. inspector shall check the box indicating that no treatment is recommended if Box A in Section 2 of the form is checked; or
   2. inspector may check the box indicating that treatment is recommended if Box B in Section 2 of the form is checked; and

      a. there is evidence of active insect infestation; or
      b. there is:

         i. no evidence of previous treatment;
         ii. evidence of insect activity that appears to have occurred after the most recent treatment; or
         iii. evidence of subterranean termites; and

I. the structure is not currently under a termite treatment service contract or warranty;
II. the structure has not been treated with a liquid soil termite treatment within the previous five years; and
III. the commercial applicator conducting the inspection describes the evidence relied upon in making the determination that treatment is recommended.

3. inspector may check the box indicating that no treatment is recommended if:

    a. Box B in section two of the form is checked; and
    b. the commercial applicator conducting the inspection:

        i. believes, based on the evidence observed, that there is not an active insect infestation; and
        ii. describes the evidence relied upon in making the determination that treatment is not recommended.

F. designate by checkmark in Section 4 any obstructed or inaccessible area of the specific structure inspected. Access coverings that are readily removed using commonly available tools, such as screwdrivers, pliers and wrenches, do not render an area obstructed or inaccessible.

G. include in Section 5 of the form:

1. any comments that are not provided for in the other sections of the form, including, but not limited to: infestation or damage observed in areas other than the specific structure inspected;
2. any comments amplifying information provided in other sections of the form; and
3. if attachments were used to detail inspection findings described in other sections of the form, a list and description of these attachments.

H. complete and sign the form within five business days following completion of the inspection.

The commercial applicator's signature on the form is the commercial applicator's certification that the inspection was conducted and reported in accordance with the requirements of Chapter 901:5-11 of the Administrative Code.

I. submit, within 10 days following completion of the inspection, a copy of the completed and signed form to the pesticide business or registered location for which the inspection was conducted.

CHAPTER 25: REFERENCES AND STUDY MATERIAL

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CHAPTER 26: GLOSSARY

- **absorption:** the movement of a chemical into plants, animals (including humans) and microorganisms.
- **acaricide:** a pesticide used to control mites and ticks. A miticide is an acaricide.
- **active ingredient:** the chemical or chemicals in a pesticide responsible for killing, poisoning or repelling the pest that are listed separately in the ingredient statement.
- **acute toxicity:** the capacity of a pesticide to cause injury within 24 hours following exposure. LD50 and LC50 are common indicators of the degree of acute toxicity. (See also **chronic toxicity**.)
- **adjuvant:** a substance added to a pesticide to improve its effectiveness or safety; additive. Examples include: penetrants, spreader-stickers and wetting agents.
- **adsorption:** the process by which chemicals are held or bound to a surface by physical or chemical attraction. Clay and high organic soils tend to adsorb pesticides.
- **aerosol:** a material stored in a container under pressure. Fine droplets are produced when the material dissolved in a liquid carrier is released into the air from the pressurized container.
- **alates:** the primary reproductives (both male and female) of the termite colony having wings.
- **algae:** relatively simple plants that contain chlorophyll and are photosynthetic.
- **algaecide:** a pesticide used to kill or inhibit algae.
- **anti-siphoning device:** a device attached to the filling hose that prevents back-flow or back-siphoning from a spray tank into a water source.
- **anti-coagulant:** a chemical that prevents normal blood clotting, and the active ingredient in some rodenticides.

- **antidote:** a treatment used to counteract the effects of pesticide poisoning or some other poison in the body.

- **arachnid:** a wingless arthropod with two body regions and four pairs of jointed legs. Spiders, ticks and mites are in the class *Arachnida.*

- **arthropod:** an invertebrate animal characterized by a jointed body and limbs and a hard body covering (exoskeleton) that is molted at intervals. Insects, mites and crayfish are in the phylum *Arthropoda.*

- **attractant:** a substance or device that will lure pests to a trap or poison bait.

- **avicide:** a pesticide used to kill or repel birds. Birds are in the class *Aves.*

- **back-siphoning:** the undesirable movement of a liquid-pesticide mixture back through the filling hose and into the water source.

- **bacteria** (singular: **bacterium**): microscopic organisms, some of which are capable of producing diseases in plants and animals, while others are beneficial.

- **bactericide:** a chemical used to control bacteria.

- **bait:** a food or other substance used to attract a pest to a pesticide or trap.

- **band application:** the application of a pesticide in a strip alongside or around a structure, a portion of a structure, or any object; same as **barrier application**.

- **barrier application:** See **band application**.

- **beneficial insect:** an insect that is useful or helpful to humans, such as insect parasites, predators, pollinators, etc.

- **biological control:** the control of pests using predators, parasites and disease-causing organisms that may be naturally occurring or introduced.

- **biomagnification:** the process where one organism accumulates chemical residues in higher concentrations from the organisms they consume.

- **botanical pesticide:** a pesticide produced from chemicals found in plants, such as nicotine, pyrethrins and strychnine.

- **brand name:** the trademarked name or designation of a specific pesticide product or device made by a manufacturer or formulator.

- **brick veneer:** the facing of brick laid against and fastened to sheathing of a frame wall or tile wall construction.

- **budding:** another means (other than swarming) for termites to form a new colony, which occurs when a number of individuals, including one or more wingless secondary reproductives, leaves a well-established colony to start a new one.

- **calibrate, calibration, calibration of equipment or application method:** the measurement of dispersal or output and adjustments made to control the rate of the dispersal of pesticides.

- **carbamates (N-methyl carbamates):** a group of pesticides containing nitrogen, formulated as insecticides, fungicides and herbicides. The N-methyl carbamates are insecticides and inhibit cholinesterase in animals.

- **carcinogenic:** the ability of a substance or agent to induce malignant/cancerous tumors .

- **carrier:** an inert liquid, solid or gas added to an active ingredient to make a pesticide dispense effectively; also, the medium, usually water or oil, used to dilute the formulated product for application.

- **caste:** a specialized subset within the termite colony that carries out a particular function within the colony. Termite castes include reproductives, workers and soldiers.

- **cellulose:** a polysaccharide that is the chief part of plant cell walls and the main food source for termites.

- **certified applicators:** individuals who are certified to use or supervise the use of any restricted use pesticide that is covered by their certification.

- **chemical name:** the scientific name of the active ingredients found in a formulated product. This complex name is derived from the chemical structure of the active ingredient.

- **chemical control:** pesticide application to kill pests.

- **chemosterilant:** a chemical compound capable of preventing animal reproduction.

- **CHEMTREC:** abbreviation for the Chemical Transportation Emergency Center, which has a toll-free number that provides 24-hour information for chemical emergencies, such as a spill, leak, fire or accident: 800-424-9300.

- **chlorinated hydrocarbon:** a pesticide containing chlorine, carbon and hydrogen, many of which are persistent in the natural environment. Some of these include chlordane, DDT and methoxychlor. These and others are rarely used in urban pest-management operations today because of their toxicity to humans and other mammals.

- **cholinesterase (acetyl cholinesterase):** an enzyme in animals that helps regulate nerve impulses. This enzyme is depressed by N-methyl carbamate and organophosphate pesticides.

- **chronic toxicity:** the ability of a material to cause injury or illness beyond 24 hours following exposure from repeated, prolonged exposure to small amounts. (See also **acute toxicity**.)

- **commercial applicator:** a certified applicator who, for compensation, uses or supervises the use of any pesticide classified for restricted use for any purpose or on any property other than that producing an agricultural commodity.

- **common name:** a name given to a pesticide's active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names, but the active ingredient typically has only one recognized common name.

- **community:** the different populations of animal species or plants that exist together in an ecosystem. (See also **population** and **ecosystem**.)

- **competent:** individuals properly qualified to perform functions associated with pesticide application. The degree of competency (capability) required is directly related to the nature of the activity and the associated responsibility.

- **concentration:** refers to the amount of active ingredient in a given volume or weight of formulated product.

- **contact pesticide:** often used in reference to a spray applied directly on a pest, a compound that causes death or injury to insects when it contacts them without having to be ingested.

- **contamination:** the presence of an unwanted substance (sometimes pesticides) in or on a plant, animal, soil, water, air or structure.

- **cultural control:** a pest-control method that includes changing human habits, such as sanitation methods and schedules, work practices, etc.

- **decontaminate:** to remove or break down a pesticidal chemical from a surface or substance.
- **defect action levels:** the maximum levels for defects, such as the presence of insect fragments, mold, or rodent hairs in food products allowed by the U.S. Food and Drug Administration (FDA).

- **degradation:** the process by which a chemical compound or pesticide is reduced to simpler compounds by the action of micro-organisms, water, air, sunlight or other agents. Degradation products are usually (but not always) less toxic than the original compound.

- **deposit:** the amount of pesticide on treated surface after application.

- **dermal toxicity:** the ability of a pesticide to cause acute illness or injury to a human or animal when absorbed through the skin. (See **exposure route**.)

- **desiccant:** a type of pesticide that draws moisture or fluids out of a pest, causing it to die. Certain desiccant dusts destroy the waxy outer coating that holds moisture within an insect's body.

- **detoxify:** to render a pesticide's active ingredient or other poisonous chemical harmless.

- **diagnosis:** the positive identification of a problem and its cause.

- **diluent:** any liquid gas or solid material used to dilute or weaken a concentrated pesticide.

- **disinfectant:** a chemical or other agent that kills or inactivates disease-producing micro-organisms; chemicals used to clean or surface-sterilize inanimate objects.

- **dose, dosage:** quantity, amount or rate of pesticide applied to a given area or target.

- **drift:** the airborne movement of a pesticide spray or dust beyond the intended target area.

- **ducts:** in a house, the round or rectangular metal, asbestos or composition-material pipes used for distributing warm air from the heating unit to rooms, or cold air from an air-conditioning unit (cold-air returns); may be embedded in or placed beneath concrete slabs.

- **dust:** a finely ground, dry pesticide formulation containing a small amount of active ingredient and a large amount of inert carrier or diluent, such as clay or talc.

- **ecosystem:** the pest-management unit that includes a community of populations with the necessary physical supporting factors (harborage, moisture, temperature) and biotic supporting factors (food, hosts) that allow an infestation of pests to persist.

- **elytra:** a pair of thickened, leathery or horny front wings found in the beetle family.

- **emulsifiable concentrate:** a pesticide formulation produced by mixing or suspending the active ingredient (the concentrate) and an emulsifying agent in a suitable carrier. When added to water, a milky emulsion is formed.

- **emulsifier, emulsifying agent:** a chemical that aids in the suspension of one liquid in another which normally would not mix together.

- **emulsion:** a mixture of two liquids that are not soluble in one another. One is suspended as very small droplets in the other with the aid of an emulsifying agent.

- **encapsulated formulation:** a pesticide formulation with the active ingredient enclosed in capsules of polyvinyl or other materials, principally used for slow release. The enclosed active ingredient moves out to the capsule surface as pesticide on the surface is removed or volatilizes, rubs off, etc.

- **endangered species:** individual plants and animals whose population has been reduced to the extent that it is near extinction and, consequently, has been designated as endangered by a federal agency.

- **entry interval:** See **re-entry interval**.

- **environment:** air, land, water, all plants, man and other animals, and the inter-relationships that exist among them.

- **EPA:** abbreviation for the U.S. Environmental Protection Agency, the federal agency responsible for ensuring the protection of humans and the environment from potentially adverse effects of pesticides.

- **EPA Establishment Number:** the number assigned by the EPA to each pesticide production plant, which must appear on all labels of that plant's product.

- **EPA Registration Number:** the identification number assigned to a pesticide product when that product is registered with the EPA for use, and which must appear on all labels of that product.

- **eradication:** the complete elimination of a pest population from a designated area.

- **exposure route, common exposure route:** the manner by which a pesticide may enter an organism, including dermal, oral or inhalation/respiratory.

- **FIFRA:** the abbreviation for the Federal Insecticide, Fungicide and Rodenticide Act, which is a federal law and its amendments that control pesticide registration and use in the U.S.

- **flow meter:** used to measure the application or delivery rate of a chemical, including the amount of chemical delivered per unit area; useful when calibrating large-volume sprayers. These meters can also measure the amount of termiticide injected into each hole for sub-slab applications.

- **flowable:** a pesticide formulation in which a very finely ground solid particle is suspended (but not dissolved) in a liquid carrier or medium.

- **fog treatment:** a fine mist of pesticide in aerosol-sized droplets (under 40 microns); not a mist or gas. After propulsion, fog droplets fall to horizontal surfaces.

- **formulation:** the pesticide product as purchased, containing a mixture of one or more active ingredients, carriers (inert ingredients) and other additives, making it easy to store, dilute and apply.

- **frass:** solid larval insect excrement mixed with wood fragments produced by wood-boring and bark-boring insects.

- **fruiting body:** the part of the fungi from which the reproductive spores are produced (conks, mushrooms, etc.).

- **fumigant:** a pesticide formulation that volatilizes, forming a toxic vapor or gas that kills in its gaseous state, and used to penetrate voids in structures to kill pests.

- **fungicide:** a chemical used to control fungi.

- **fungus** (plural **fungi**): a group of small, often microscopic, organisms in the plant kingdom that cause rot, mold and disease. Fungi need moisture or a damp environment to grow. Wood rots require that host wood has a moisture content of at least 19%. Fungi are extremely important in the diet of many insects.

- **general-use (unclassified) pesticide:** a pesticide that can be purchased and used by the general public. (See also **restricted-use pesticide**.)

- **granule:** a dry pesticide formulation whose active ingredient is either mixed with or coated onto an inert carrier to form a small, ready-to-use, low-concentrate particle that normally does not present a drift hazard. Pellets differ from granules only in their precise uniformity, larger size and shape.

- **groundwater:** natural water sources located beneath the soil surface from which springs, well water, etc., is obtained. (See also **surface water**.)

- **harborage:** any place or site that shelters and provides sustenance (such as food and water) required for the survival of a particular organism.

- **hardwood:** wood from non-evergreen trees, such as maple, oak, ash, etc.

- **hazard:** See **risk**.

- **heartwood:** a cylinder of dark-colored, dead wood in the center of the tree that is no longer active in conducting sap or water.

- **herbicide:** a pesticide used to kill or inhibit plant growth.

- **host:** any animal or plant on or in which another lives for nourishment, development or protection.

- **hypha** (plural **hyphae**): one of the threadlike structures of a fungus.

- **IGR:** abbreviation for insect-growth regulator or juvenoid, which is a pesticide constructed to mimic insect hormones that control molting and the development of some insect systems affecting the change from immature to adult. (See **juvenile hormone**.)

- **inert ingredient:** in a pesticide formulation, an inactive material without pesticidal activity.

- **ingredient statement:** the portion of the label on a pesticide container that gives the name and amount of each active ingredient and the total amount of inert ingredients in the formulation.

- **inhalation:** taking a substance in through the lungs; breathing in. (See **exposure route**.)

- **insect growth regulator:** See **IGR**.

- **insecticide:** a pesticide used to manage or prevent damage caused by insects, sometimes generalized to be synonymous with pesticide.

- **insects, *Insecta:*** a class in the phylum *Arthropoda* characterized by a body composed of three segments and three pairs of legs.

- **inspection:** to examine for pests, pest damage, other pest evidence, etc. (See **monitoring**.)

- **integrated pest management:** See **IPM**.

- **IPM:** abbreviation for integrated pest management, which is a planned pest-control program whose methods are integrated and used to keep pests from causing economic, health-related and/or aesthetic injury; includes reducing pests to a tolerable level. Pesticide application is not the primary control method but is an element of IPM, as are cultural and structural alterations. IPM programs stress communication, monitoring, inspection and evaluation (including keeping and using records).

- **joist:** one of a series of parallel beams, usually 2 inches thick, used to support floor and ceiling loads, and supported, in turn, by larger beams, girders, bearing walls or a foundation.

- **juvenile hormone:** a hormone produced by an insect that inhibits change or molting. As long as juvenile hormone is present, the insect does not develop into an adult but remains immature.

- **label, labeling:** all printed material attached to or on a pesticide container; the pesticide product label and other accompanying materials that contain directions that pesticide users are legally required to follow.

- **larva** (plural **larvae**): the developmental stage of an insect that hatches from an egg and undergoes complete metamorphosis to the adult stage; a mature larva becomes a pupa. Some other invertebrates have larvae, but they do not involve urban pests.

- **LC50 (lethal concentration):** the concentration of a pesticide, usually in air or water, that kills 50% of a test population of animals. LC50 is usually expressed in parts per million (ppm). The lower the LC50 value, the more acutely toxic the chemical is.

- **LD50 (lethal dose):** the dose or amount of a pesticide that can kill 50% of the test animals when eaten or absorbed through the skin. LD50 is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The lower the LD50, the more acutely toxic the pesticide is.

- **leaching:** the movement of a substance with water downward through soil.

- **lignin:** a complex structural polymer that imparts rigidity to certain plant cell walls, especially the walls of wood cells.

- **Material Safety Data Sheets (MSDS):** These data sheets contain specific information on toxicity, first aid, personal protective equipment (PPE), storage and handling precautions, spill and leak cleanup and disposal practices, transportation, physical data, and reactivity data. MSDS are available from product manufacturers.

- **mesothorax:** the second segment of an insect's thorax, with one pair of legs and (usually) one pair of wings attached.

- **metamorphosis:** the change in the shape or form of an animal; used when referring primarily to insect development.

- **metathorax:** the third segment of an insect's thorax, with one pair of legs and often one pair of wings attached.

- **microbial degradation:** the breakdown of a chemical by micro-organisms.

- **microbial pesticide:** bacteria, viruses, fungi, and other micro-organisms that are used to control pests; also called **biorationals**.

- **micro-organism:** an organism so small that it can be seen only with the aid of a microscope.

- **miticide:** a pesticide used to control mites. (See **acaricide**.)

- **mode of action:** the way in which a pesticide exerts a toxic effect on the target plant or animal.

- **moisture meter:** a device used to the measure moisture content of wood. A moisture content greater than 20% indicates conditions that will lead to decay.

- **molluscicide:** a chemical used to control snails and slugs.

- **molt:** the periodic shedding of the outer layer. The exoskeleton of insects is shed periodically.

- **monitoring:** ongoing surveillance, including inspection and record-keeping. Monitoring allows technicians to evaluate pest population-suppression, identification of infested and non-infested sites, and management of the progress of the control program.

- **mud tubes:** See **shelter tubes**.

- **necrosis:** the dying process of living tissues, organs and systems; the death of plant or animal tissues that results in the formation of discolored, sunken and/or dead (necrotic) areas.

- **node:** nodes are swollen segments found at the narrow connection between the thorax and abdomen of ant species. The nodes may be helpful in identifying the ant species; most ant have one node while others have two.

- **non-residual pesticide:** pesticides applied to obtain effects only during the time of treatment.

- **non-target organism:** any plant or animal other than the intended target(s) of a pesticide application.

- **nymph:** the developmental stage of insects that hatch from eggs and undergo gradual metamorphosis to adulthood. Nymphs become adults.

- **oral toxicity:** the ability of a pesticide to cause injury or acute illness when taken by mouth; one of the common exposure routes.

- **organophosphates:** a large group of pesticides that contain the element phosphorus and inhibit cholinesterase in animals.

- **parasite:** a plant, animal or micro-organism living in, on, or with another living organism for the purpose of obtaining all or part of its food.

- **paresthesia:** a reaction to dermal exposure to some pesticides (especially pyrethroids) having symptoms similar to a sunburn sensation of the face and especially the eyelids. Sweating, exposure to sun or heat, and application of water aggravate the disagreeable sensations. This is a temporary effect that dissipates within 24 hours. For first aid, wash with soap and water to remove as much residue as possible, and then apply a vitamin E oil preparation or cream to the affected area. Persons susceptible to paresthesia should choose a pesticide with a different active ingredient and/or formulation.

- **pathogen:** a disease-causing organism.

- **personal protective equipment (PPE):** devices and clothing intended to protect a person from exposure to pesticides, including items such as long-sleeved shirts, long trousers, coveralls, suitable hats, gloves, shoes, respirators, and other safety items as needed.

- **pest management:** See **IPM**.

- **pest:** an undesirable organism, including (1) any insect, rodent, nematode, fungus, weed or (2) any other form of terrestrial or aquatic plant or animal life or virus, bacteria, or other micro-organism (except viruses, bacteria or other micro-organisms on, or in live humans or other live animals) which the overseeing administrator declares to be a pest under FIFRA, Section 25(c)(1).

- **pesticide:** a chemical or other agent used to kill, repel or otherwise control pests or to protect from a pest.

- **pH:** a measure of the acidity and alkalinity of a liquid. Acidic is below pH 7; basic or alkaline: above pH 7 (up to 14).

- **pheromone:** a substance emitted by an animal to influence the behavior of other animals of the same species. Some are synthetically produced for use in insect traps.

- **photodegradation:** the breakdown of chemicals by the action of light.

- **physical control:** habitat alteration or changing the infested physical structure, such as by caulking holes and cracks, tightening elements around doors and windows, reducing moisture and ventilation, etc.

- **phytotoxicity:** injury to plants caused by a chemical or other agent.

- **point of runoff:** the point at which a spray starts to run or drip from the surface to which it is applied.

- **Poison Control Center:** a local agency or hospital that has current information regarding the proper first-aid techniques and antidotes for poisoning emergencies; typically listed in local telephone directories.

- **population:** individuals of the same species that, locally, make up a community. (See **ecosystem**.)

- **precipitate** (noun): the solid substance that forms in a liquid and settles to the bottom of a container; a material that no longer remains in suspension.

- **predator:** an animal that attacks, kills and feeds on other animals. Examples of predacious animals include hawks, owls, snakes, many insects, etc.

- **professional:** one who is able to make judgments based on training, experience and an available database.

- **propellant:** the inert ingredient in pressurized products that forces the active ingredient from the container.
- **pronotum:** the area just behind an insect's head at the upper plate of the prothorax.
- **prothorax:** the first segment of an insect's thorax, with one pair of legs attached.
- **protozoan**: a unicellular animal. Termites are dependent on a specific type of protozoan to help them digest cellulose.
- **pupa** (plural **pupae**): the developmental stage of insects that undergo complete metamorphosis, defined as major changes that occur from the larval to the adult form.
- **rate of application:** the amount of pesticide applied to a plant, animal, unit area or surface, usually measured as per acre, per 1,000 square feet, per linear feet or per cubic feet.
- **ready-to-use pesticide:** a pesticide that is applied directly from its original container consistent with label directions, such as an aerosol insecticide or rodent bait box, and does not require mixing or loading prior to application.
- **re-entry interval:** the length of time following an application of a pesticide when entry into the treated area is restricted. (See **entry interval**.)
- **registered pesticides:** pesticide products that have been registered with the U.S. EPA for the applications listed on the product label.
- **repellent:** a compound that keeps insects, rodents, birds or other pests away from plants, domestic animals, buildings or other treated areas.
- **reproductives:** the caste within the termite colony that is responsible for reproduction and for establishing new termite colonies. Subterranean termite colonies have both primary winged males and females and supplementary wingless males and females (or those having short, non-functional wings).
- **residual pesticide:** a pesticide that continues to remain effective on a treated surface or area for an extended period following its application.

- **residue:** the pesticide's active ingredient or its breakdown product(s) that remain in or on the target after treatment.

- **restricted-use pesticide:** a pesticide that can be purchased and used only by certified applicators or persons under their direct supervision; a pesticide classified for restricted use under FIFRA, Section 3(d)(1)(C).

- **rhizomorph:** a thread or root-like fungal structure made up of hyphae.

- **risk:** the probability that a given pesticide will have an adverse effect on humans or the environment in a given situation.

- **rodding:** a method of applying termiticide. Long rods may be used to apply termiticide into the soil next to a foundation wall, while shorter rods are used to inject termiticide into the voids of walls and through concrete slabs.

- **rodenticide:** a pesticide used to control rodents.

- **runoff:** the movement of water and associated materials on the soil surface. Runoff usually proceeds to bodies of surface water.

- **sapwood:** a lighter-colored ring of wood surrounding the heartwood of a tree that consists of cells that are actively conducting water and sap.

- **seasoned:** lumber that has been chemically treated with wood preservatives and prepared for use. (See also **unseasoned**.)

- **sheathing:** the structural covering, usually wood boards or plywood, used over the studs and rafters of a structure. Structural building board is normally used only as a wall sheathing.
- **shelter tubes (mud tubes):** tunnels constructed by subterranean termites to help them pass over exposed areas and reach new food sources (cellulose). Termites require a constant source of moisture, and shelter tubes provide a moist environment while allowing them to maintain contact with the soil. The tubes also serve to conceal the termites and protect them from natural enemies, such as ants.

- **signal words:** required word(s) that appear on every pesticide label to denote the relative toxicity of the product. The most common signal words are: "DANGER: POISON," "DANGER," "WARNING" and "CAUTION."

- **site:** areas of actual pest infestation, which should be treated specifically or individually.

- **soil injection:** the placement of a pesticide below the surface of the soil; common application method for termiticides.

- **soil drench:** to soak or wet the ground surface with a pesticide. Large volumes of the pesticide mixture are usually needed to saturate the soil to any depth.

- **soil incorporation:** the mechanical mixing of a pesticide product with soil.

- **soldiers:** refers to the caste within a termite colony that is responsible for the defense of the colony.

- **solution:** a mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are completely dissolved, such as sugar in water.

- **solvent:** a liquid that will dissolve another substance (solid, liquid or gas) to form a solution.

- **sounding:** a method of detecting damaged wood by tapping on the wood and listening for a hollow sound, which indicates the presence of cavities that are not visible from the surface.

- **space spray:** a pesticide that is applied as a fine spray or mist to a confined area.

- **spot treatment:** application of a pesticide to limited areas where pests are likely to be found; a method used to avoid contact of pesticides with food, utensils and people.

- **springwood:** the wood produced early in the season that is of lower density than wood produced later in the season.

- **stomach poison:** a pesticide that must be eaten by a pest in order to be effective; it will not kill on contact.

- **surface water:** water on the earth's surface, such as rivers, lakes, ponds, streams, etc. (See **groundwater**.)

- **suspension:** a pesticide mixture consisting of fine particles dispersed or floating in a liquid, usually water or oil, such as wettable powders in water.

- **swarmers:** the winged primary male and female reproductives of a termite colony. They leave the colony in swarms, usually in the spring or fall. These swarms are often the first visible indication that a termite infestation is present. (See also **alates**.)

- **swarming:** when winged termite primary reproductives leave the colony in great numbers to mate and start a new colony.

- **target:** the plants, animals, structures, areas and/or pests at which the pesticide or other control method is directed.

- **technical material:** the pesticide's active ingredient in its pure form as it is manufactured by a chemical company. It is combined with inert ingredients or additives in formulations, such as wettable powders, dusts, emulsifiable concentrates or granules.

- **termite shield:** a shield, usually of non-corrosive metal, placed in or on a foundation wall or other mass of masonry, or around pipes, to prevent the passage of termites.

- **thorax:** the middle part of an insect's body between its head and abdomen. It is divided into three segments: the prothorax, mesothorax and metathorax. A pair of legs is attached to each thoracic region.

- **toxic:** poisonous to living organisms.

- **threshold:** the level of pest density; the number of pests observed, trapped, counted, etc., that can be tolerated without an economic loss or aesthetic injury. Pest thresholds in urban pest management may be site-specific; for example, different numbers of cockroaches may be tolerated at different sites (e.g., hospitals and garbage rooms). A threshold may be set at zero (e.g., termites in a wooden structure, flies in a hospital operating room, etc.).

- **tolerable levels of pests:** The presence of pests at certain levels is tolerable in many situations. Totally eliminating pests in certain areas is sometimes not achievable without major structural alterations, excessive control measures, unacceptable disruption, unacceptable cost, etc. Pest levels that depend on pest observations vary. The tolerable level in some situations will be zero (e.g., termites). Urban pest management programs usually have lower tolerable levels of pests than agricultural programs.

- **toxicant:** a poisonous substance, such as the active ingredient in a pesticide formulation.

- **toxicity:** the ability of a pesticide to cause harmful, acute, delayed or allergic effects; the degree or extent to which a chemical or substance is poisonous.

- **toxin:** a naturally occurring poison produced by plants, animals or micro-organisms, such as the poison produced by the black widow spider, the venom produced by snakes, the botulism toxin, etc.

- **trenching:** a method for applying termiticide to soil. Soil is removed by digging a trench to within about 1 foot above the footing. As the soil is replaced, it is treated with termiticide.

- **trophallaxis:** major form of communication within a termite colony that involves the mutual exchange of nutrients and the transfer of food between colony members. Trophallaxis permits the efficient use of nutrients within the colony, enhances recognition of colony members, distributes chemicals involved in caste regulation, and transfers cellulose-digesting protozoans.

- **unseasoned:** lumber that has not yet been chemically treated. (See also **seasoned**.)

- **unclassified pesticide:** See **general-use pesticide**.

- **urban:** a standard metropolitan area (SMA) or a town of 2,500(+) residents.

- **urban pest management:** management of pest infestations that are normally problems in urban areas. Urban pest management involves reducing pest populations that cause health-related problems to tolerable numbers in and around homes and structures. Urban pest management may or may not focus on reducing economic injury but it always deals with health or aesthetic injuries.

- **use:** the performance of pesticide-related activities requiring certification, including application, mixing, loading, transport, storage and handling after the manufacturing seal is broken; care and maintenance of application and handling equipment; and disposal of pesticides and their containers in accordance with label requirements. Uses not needing certification include long-distance transport, long-term storage, and ultimate disposal.

- **vapor barrier:** material used to retard the movement of water vapor into walls or slabs to prevent condensation form forming in them; a covering used over dirt in crawlspaces. Common materials include polyethylene film and asphalt paper.

- **vapor pressure:** the property that causes a chemical to evaporate. The higher the vapor pressure, the more volatile the chemical is or the easier it will evaporate.

- **vector:** a carrier, such as an animal (e.g., insect, nematode, mite) that can carry and transmit a pathogen from one host to another.

- **vertebrate:** an animal characterized by a segmented backbone or spinal column.

- **virus:** ultramicroscopic parasites composed of nucleic acids and proteins. Viruses can only multiply in living tissues. They cause many animal and plant diseases.

- **volatility:** the degree to which a substance changes from a liquid or solid state to a gas at ordinary temperatures when exposed to air.

- **water table:** the upper level of the water-saturated zone in the ground.

- **wettable powder:** a dry-pesticide formulation in powder form that forms a suspension when added to water.

- **workers:** the sexually underdeveloped caste of a termite colony that is responsible for most of the work of the colony, including foraging, feeding and grooming of the other castes (including the queen), building and repairing the nest, and making the tunnels. They are the most numerous and destructive members of the colony.

- **zone:** the management unit; an area of potential pest infestation made up of infested sites. Zones contain pest food, water and harborage. A kitchen-bathroom arrangement in adjoining apartments might make up a zone; a kitchen, storeroom, waiters' station, and loading dock at a restaurant may make up another. Zones may also be established by eliminating areas with little likelihood of infestation and treating the remainder as a zone. A zone is an ecosystem.

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