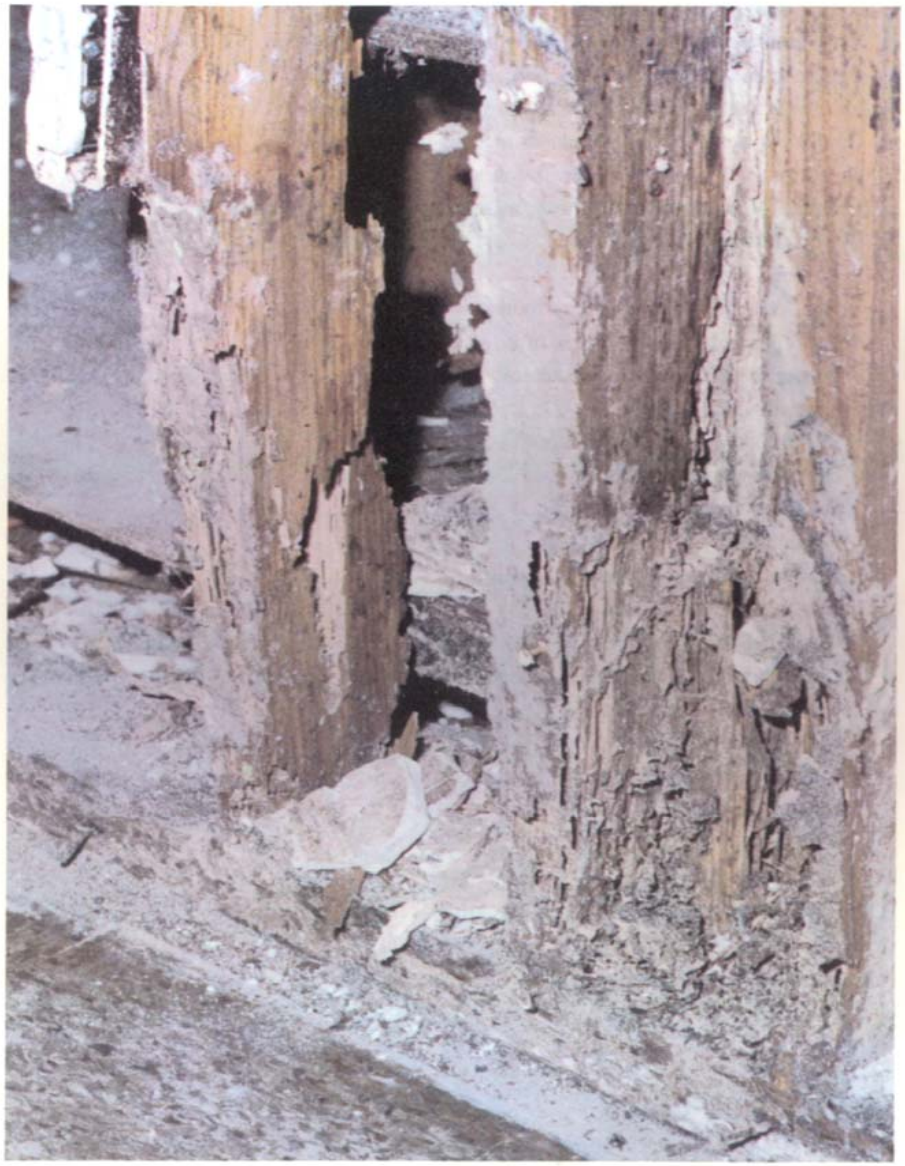
United States
Department of
Agriculture

Forest
Service

Home and
Garden
Bulletin 64

Subterranean Termites—

Their Prevention and Control in Buildings



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For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Subterranean Termites — Their Prevention and Control in Buildings

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Home and Garden Bulletin 64

U.S. Department of Agriculture
Forest Service

Washington, D.C.

Revised February 1989

Introduction

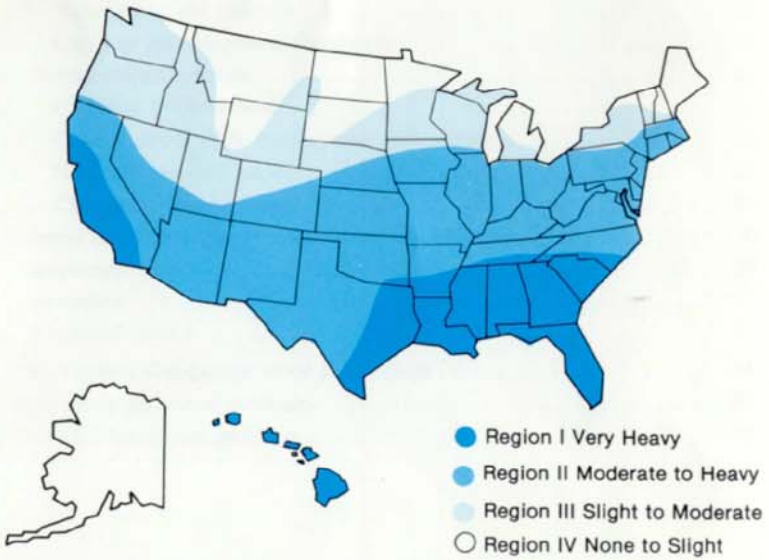
Subterranean termites are the most destructive and economically important insect pests of wood and other cellulose products. They attack wood throughout most of the United States with the exception of Alaska. They are most common, and hence cause the most destruction, in the warmer regions (fig. 1).

Although several distinct types of termites occur in the United States, the vast majority of the loss due to termites is caused by subterranean species.

Termites have a great economic impact on wood used in and around buildings. They also do considerable damage to wood used as utility poles, fence posts, or similar products. Although it is difficult to establish the exact cost of termite control, estimates range from $100 million to $3.5 billion yearly. Costs for damage repairs and chemical treatments are important considerations in any such dollar figure. Furthermore, undetected or unchecked termite damage may result in large, unreported monetary losses. The annual cost from termite damage and control efforts probably exceeds $750 million. As more houses are built, there is a greater opportunity for economic losses due to termites.

The rising costs of termite control are attributed to several factors. Poorly designed slab-on-ground construction and greater use of concrete and masonry terraces adjacent to foundation walls favor termite attack and result in increased damage to buildings. Repairs, remodeling, and landscape changes made without regard to termite prevention and control often lead to termite problems and impair the effectiveness of any prior chemical treatment.

Figure 1. — Relative hazard of subterranean termite infestations in the United States.



Preventive efforts in the planning stage and during construction may save the future homeowner much anxiety and expense. However, a cooperative effort to safeguard against termite attack is required by architects, builders, pest control operators, and homeowners in the initial stages of housing construction. Buildings should be designed and constructed to minimize moisture uptake and retention by wood. Additions or repairs to buildings or changes in landscape also should be designed to minimize the chances of termite infestation.

A combination of nonchemical and chemical prevention and control techniques offers the most effective program for subterranean termite control. Sanitation measures and chemical treatments are recommended. Proper sanitation involves removing all stumps and wooden debris from a building site before and after construction. Chemical protection involves pretreating the soil with an approved chemical. Chemical pretreatment is very important because it provides a barrier against termite movement into wooden housing parts.

Only a small percentage of the approximately 75 million single family dwelling units in the United States have been treated to control termites. Few homes are treated during construction, although this is the best and most economical course. It often is more difficult and costly to apply effective control measures after a building has become infested with termites, but a control program usually can be successfully implemented. An infested building should be examined to determine which type of termite is causing the damage, the extent of termite infestation, and the measures needed to prevent further damage. Some structures require simple physical changes, repairs, or chemical treatments that can be made by the owner. Others need major changes or complicated chemical treatments that require the services of a professional who has knowledge of termite habits and is experienced in termite control.

This bulletin suggests methods for preventing subterranean termite attack in new construction. When building or buying a new home or remodeling, you may want to check these termite prevention measures with the contractor. This publication also tells where to look for termites in existing buildings, how to recognize their damage, and how to control them by both structural and chemical means.

Termites—biological considerations

Proper termite identification and a knowledge of the species' biology are essential elements in termite control. This information provides a foundation for control methods based on the habits and behavior of the termites.

Termite ecology

In their natural habitats, termites are considered beneficial insects because they break down dead or dying plant materials, and thus they are an important part of the nutrient cycle. However, when termites feed on wooden structures, they become pests.

Based on ecological considerations, three types of termites occur in the United States: (1) drywood, (2) dampwood, and (3) subterranean. Drywood termites build their nests in sound, dry wood above ground. Dampwood species initially locate their nests in moist, decaying wood but can later extend tunnels into drier parts of the wood. Subterranean termites are more dependent on an external moisture source, and they typically dwell in the soil and work through it to reach wood above ground.

The soil provides several advantages that make it suitable as the dwelling for subterranean termites. It serves as a source of moisture that protects termites against drying out, shields termites from predators, and is used as a building material for construction of shelter tubes above ground. Termites can excavate passageways through the soil to reach food sources. If moisture is available from a source other than soil, subterranean termites may not require connection to the soil. Thus, isolated, aboveground infestations may occur in homes where subterranean termites have access to water from condensation, leaking pipes, roofs, or other sources.

Distribution of subterranean termites

Subterranean termites are found throughout the tropical and temperate parts of the world but they predominate in the tropical and subtropical regions. In the United States, they occur in greatest numbers throughout the Southeastern States and in southwestern California. The relative hazard of termite infestations tends to decrease as one moves northward (fig. 1). In any specific locality, however, termite hazard may vary greatly depending on factors such as soil type, moisture, and construction practices.

Subterranean termites probably have existed throughout their present range for millions of years. Most of the termite damage in the United States is caused by native species. There is no evidence of the general introduction or spread of termites from the tropics to the United States or of widespread movement of any of our native species from the Southern to the Northern States. Infestations in buildings, particularly in the Northern States, have become more common with the general adoption of central heating units; heated basements also enhance termite activity around struc-

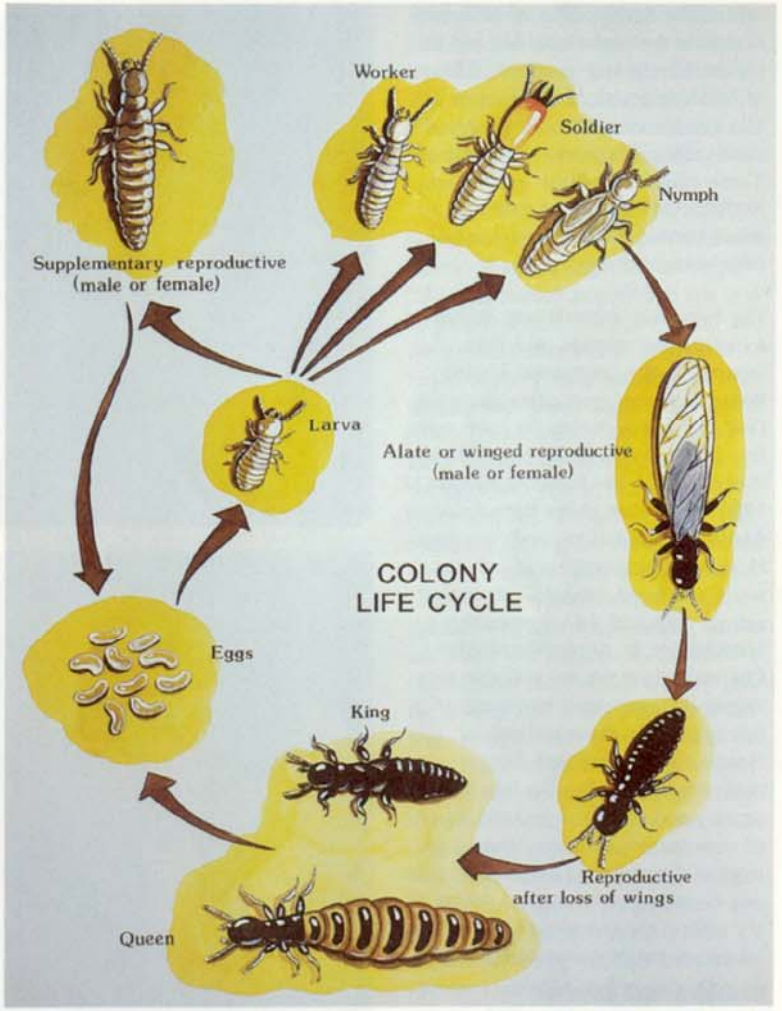


Figure 2. — Typical subterranean termite life cycle.

tures. The development of suburban homes in forested areas also has increased the termite problem. Changes in building practices and uses of certain construction materials increase the likelihood of termite infestations. These situations help to explain why termites have become a problem in areas where formerly they were of little economic importance.

The Formosan subterranean termite, an introduced species, was first reported in the continental United States in several port cities along the Gulf of Mexico during the mid- and late-1960's, but it is not yet widely distributed. It was found in Florida in 1980. Since then it has been found in Alabama, Mississippi, and Tennessee. However, transportation of infested wood and wood products rather than natural dispersal flights probably accounts for its patchy distribution. Currently there are no available data suggesting long-range movement of this species on the mainland. In Hawaii, this termite was first discovered soon after the turn of the century and has since become a pest of considerable economic impact on most of the major islands. Geographic and climatic conditions and predators are among the factors influencing the establishment of introduced species.

Biological and physical characteristics of the subterranean termite colony

Termites are social insects that live in highly organized colonies. Each colony is composed of individuals that have different physical features (fig. 2) and/or behavioral

3 (A)

3 (B)

Figure 3. — Three castes are found in colonies of the eastern subterranean termite: (A) worker, (B) soldier, and (C) winged reproductive

3 (C)

4

Figure 4. — The body of the female reproductive is greatly expanded with developing eggs.

roles. Three major types of individuals are found in this caste system: workers, soldiers, and reproductives. The species of termite can be determined by physical characteristics of the soldier and winged reproductive.

Behavioral and physical characteristics distinguish the different termite castes. Workers (fig. 3A) are wingless, soft-bodied insects that are gray or yellow-white. They are found in the greatest numbers in a subterranean termite colony and are the ones usually seen when a piece of infested wood is examined. The duties of these sterile individuals are to care for eggs and young, feed and clean other termites, forage for food, and construct and repair shelter tubes and other workings. This is the termite caste that actually eats the wood. Soldiers (fig. 3B) have larger, brownish heads and longer mouthparts (mandibles) than workers. They guard the colony and defend against predators. Reproductives, or sexual adults, have black or yellow-brown bodies. They have two pairs of long, whitish, translucent wings of equal size at the time they disperse from a colony (fig. 3C), but they shed their wings soon after flight. With increased age, the body of a functioning female reproductive (fig. 4) may become greatly expanded with developing eggs and she will attain a size several times that of workers.

Winged ants often are mistaken for winged termites, but characteristics that can be seen with the unaided eye will help differentiate the two insects.

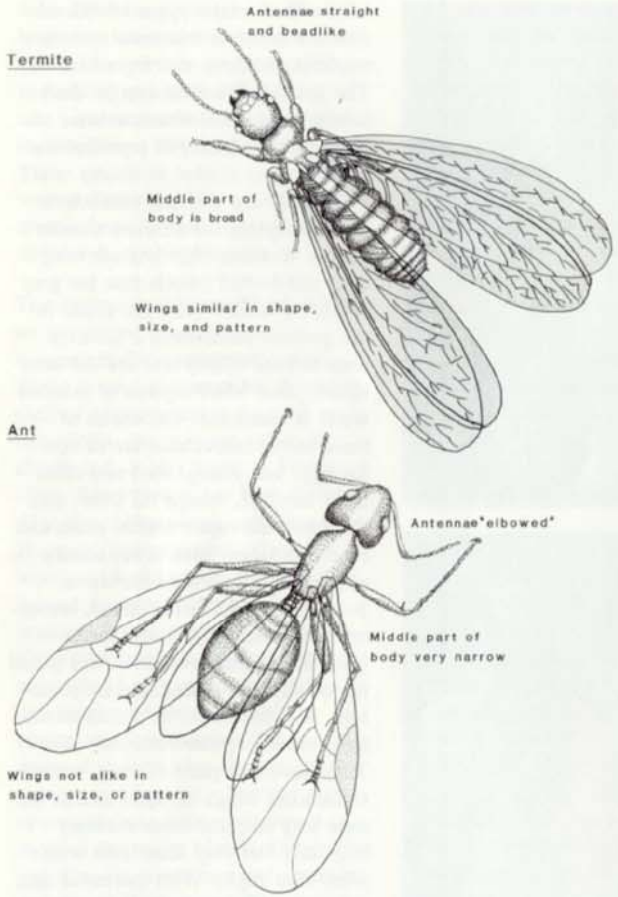


Figure 5. — Physical characteristics distinguish winged ants and termites.

Ants have two pairs of transparent wings of unequal size; termites have four equal-sized wings. Also, the region of the body behind the wings is "pinched" in ants but broader in termites. These and other distinguishing features are pictured in figure 5.

Ants generally have harder bodies than termites.

A subterranean termite colony is essentially self-perpetuating. When the colony is composed of a large number of individuals, a relatively small percentage of the workers develop into winged reproductives that then fly from the workings in swarms to establish new colonies. Most winged reproductives perish during flight because they are eaten by predators such as other insects, birds, and lizards, or they die from desiccation. The time of day and year when flights occur varies with the species of termite and its geographic location. Flights often occur after the first warm days of spring following a rain, but they may occur any time of the year. In buildings with heated basements, termites occasionally fly during winter.

Males and females in the flights are referred to as kings and queens, respectively. They shed their wings after flight, and a pair excavates a cell in or near wood in the ground and then mate. Most subterranean species that occur in this country lay fewer than a hundred eggs during the first year, but egg laying increases with time. In some colonies, workers may develop into supplementary reproductives (fig. 4), which supplement the egg laying of the original queen. A colony more than 5 or 6 years old may contain several thousand termites and produce winged reproductives each year.

Materials damaged by subterranean termites

The principal food of subterranean termites is cellulose, obtained from wood and other plant tissues. Termites, therefore, feed on wooden portions of buildings, utility poles, fence posts, or any other wood product. They also damage paper, fiberboard, and various types of fabrics derived from cotton and other plants. They occasionally are found in living plants. As termites search for food, they may penetrate and damage many noncellulose materials, including plastics, although these do not serve as food sources. However, the greatest economic impact is to the wood in buildings.

Conditions favoring subterranean termite infestation

Understanding biological requirements and conditions that favor termite activities better prepares one to inspect buildings and identify potential problem areas. An important consideration is the termites' dependency on moisture. Their high moisture requirement increases the likelihood that they will maintain contact with the soil and/or locate near areas where water collects.

Subterranean termites become most abundant in moist, warm soil containing a large supply of food in the form of wood or other cellulose material. Such conditions often are found beneath buildings where there is inadequate site drainage or poor ventilation and where scraps of lumber, formboards, grade stakes, stumps, or roots are left in the soil. Once termites locate such an area, they can move into aboveground housing parts in a variety of ways. Termites invade most buildings through wood close to or in contact with the soil, particularly at porches,

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Figure 6. — Surface of wood removed to show damage done by termites and the specks of excrement on the gallery walls.

7

Figure 7. — Wood attacked by subterranean termites has a honeycombed appearance because the workers tunnel along the softer grain of the wood.

steps, terraces, fences, or planters. Termites can easily enter small cracks or voids in foundations and concrete floors to reach wood that does not touch the soil. Termite activity is increased and prolonged, even in northern areas, when soil within or adjacent to heated basements is kept warm throughout most of the year.

Termites may eliminate their contact with the soil in cases where an aboveground moisture source is available. Damp wood near sinks, toilets, and leaking pipes and wood kept moist by runoff water, as from the roof or gutters, are prime locations for termite infestation.

Detection of subterranean termite damage

Early detection of the signs of termite infestations and subsequent control measures should enable homeowners to protect their dwellings against termites. A relatively simple, careful inspection of one's home may reveal previously undetected signs of termite activity.

Termite damage to wood often is not noticeable on the surface because workers avoid exposure to air by constructing galleries within the materials they attack. The exterior surface of the wood must be stripped away in order to see the extent of

8(A)

8(B)

Figure 8. — Shelter tubes allow termites to tunnel across exposed areas: (A) shelter tubes constructed over foundation, (B) termites within a shelter tube.

damage. Severely damaged wood may have a hollow sound when tapped. Wood attacked by subterranean termites typically is recognized by the extensive tunnels that run along the grain (figs. 6 and 7). These galleries often are covered with yellow-brown or gray specks of excrement and soil. Occasionally, termites completely honeycomb wooden timbers, leaving little more than a thin wooden shell. Subterranean termites do not reduce the wood to a powdery mass or push wood particles to the outside as do many other wood-boring insects.

In exposed areas, termites must protect themselves from the drying effects of air. Thus, earthen shelter tubes constructed over the surface of foundation walls are a typical sign of termite infestation (fig. 8A). These tubes are usually about 0.25 to 0.5 inch (0.6 to 1.2 cm) wide, and termites use them as passageways between the wood and the soil (fig. 8B). To determine if an infestation is active, shelter tubes may be broken or scraped off surfaces; then observations should be made to determine whether termites repair the damaged tubes or build new ones.

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Figure 9. — Carton nest produced by the Formosan subterranean termite.

10

Figure 10. — Discarded termite wings may be the most obvious sign of a nearby colony.

Most subterranean termite species found in the United States usually do not construct a clearly defined nest. However, the Formosan subterranean termite often builds "carton" nests within walls. This carton nest is a honeycombed mass composed of chewed wood, saliva, and feces (fig. 9), which functions to retain water and protect the termites from predators. It allows this species to build aboveground nests. Although an occupied carton nest is relatively moist and pliable, abandoned nests dry and harden to a concrete-like consistency.

Large numbers of winged termites swarming from the soil or wood are often the most obvious sign of a nearby termite colony. Although flights may not be observed, discarded wings on the floor beneath doors or at window sills (fig.10) suggest that winged termites have either emerged within a building and have been unable to escape, or have emerged nearby and were attracted to lights in the house. A subterranean termite colony producing winged reproductives is considered to be well established and usually contains at least several thousand colony members. In six field colonies collected during April 1981 in Mississippi, the mean number of subterranean termites was approximately 240,000, and all colonies contained winged reproductives.

Prevention of subterranean termite attack during construction

The best and least expensive time to protect against subterranean termites is during the planning and construction of a building. This has been learned through research on the habits and behavior of termites and through experience in their control.

Improper design and construction of buildings, resulting either from a lack of knowledge of or indifference to the termite problem, are favorable to infestation. It is therefore important to use good building practices and chemical soil treatments during construction.

Good building practices

The building site—All roots, stumps, and other wood debris should be removed from the building site before starting construction. Burying such material will only increase the probability of an infestation. Wooden spreader sticks and grade stakes should be removed before the concrete hardens. Formboards and scraps of lumber also should be removed before filling or backfilling around the completed foundation. Wood should not be buried beneath porches and steps (fig. 11). No scraps of lumber should be left on the soil surface beneath or around the building after construction.

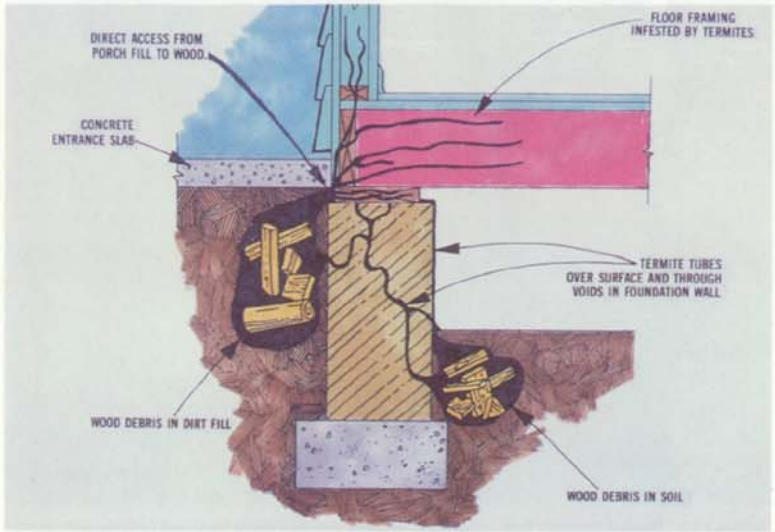

Figure 11. — Termite colonies can develop in wood debris or soil and gain entrance into a building, particularly at the concrete entrance slabs of porches.

To prevent an unfavorable moisture buildup in the soil beneath a building, the soil surface around the building should be sloped so that surface water will drain away from it. Gutters and downspouts attached to eaves can help remove water quickly. Where there are problems of poor surface drainage, as on flat sites or around buildings with basements, the use of drainage tile around the outside of the building foundation may prove helpful.

Wall and pier (crawl-space) foundations—All foundations should be made as impervious to termites as possible to prevent hidden attack on the wood above. The proper construction of foundations is one of the most important measures that can be taken to protect against termites and should be considered very carefully. Crawl-space foundations may be rated in the decreasing order of relative resistance to penetration by termites as follows:

1. Poured concrete wall and pier foundations (fig. 12), properly reinforced to prevent large shrinkage or settlement cracks. Cracks 0.03 inch (0.8 mm) or more in width permit the passage of termites.

2. Hollow block or brick wall and pier foundations:

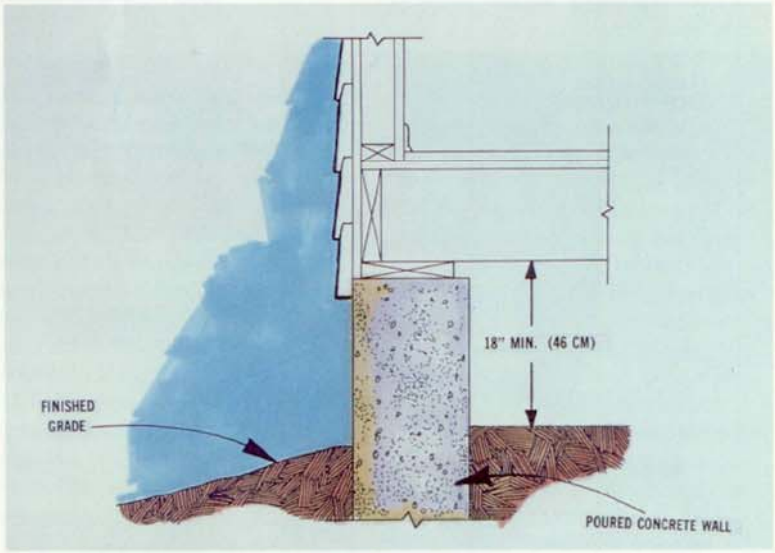

Figure 12. — Poured concrete foundation walls or piers that are easily inspected offer protection against hidden termite infestations.

   a. Capped with a minimum of 4 inches (10 cm) of reinforced poured concrete (fig. 13).
   b. Capped with precast solid concrete blocks, all joints completely filled with cement mortar.
   c. Top course of hollow blocks and all joints completely filled with concrete. Where hollow blocks remain open no protection is provided unless all voids are chemically treated.

3. Wooden piers, or posts used for foundations or piers, pressure-treated with an approved preservative by a standard pressure process.

Raised porches and terraces of concrete or masonry—Dirt-filled porches and terraces contribute to a large proportion of all termite infestations in buildings. Therefore, spaces beneath concrete porches, entrance platforms, and similar raised units should not be filled with soil. Such spaces should be left open with access doors for inspection. If this cannot be done, or if the spaces beneath such raised units must be filled, leave 6 inches (15 cm) of clearance between soil and wood and thoroughly treat the soil with an approved chemical (see section on chemical soil treatment, pages 23–28).

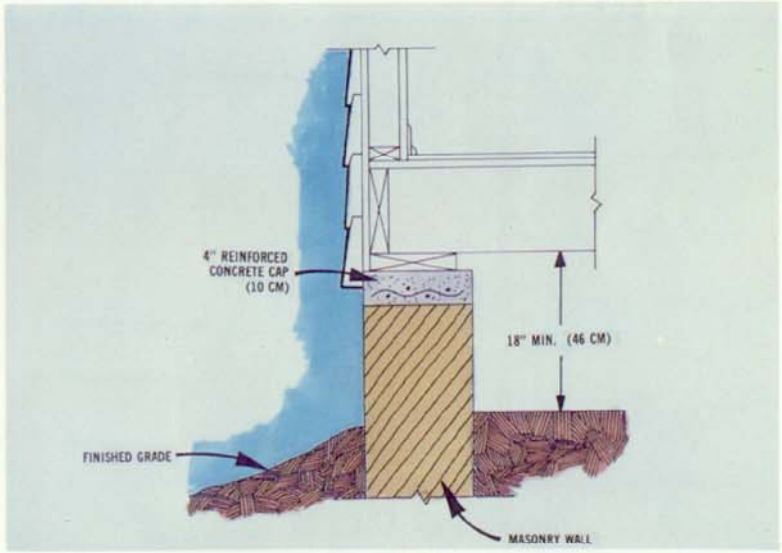

Figure 13. — A reinforced poured concrete cap on masonry walls or piers prevents hidden attack by termites. A minimum clearance of 18 inches (46 cm) under the floor joists will allow inspection for termite tubes or possible cracking of the cap.

Clearance between wood and soil—The outside finished grade should always be equal to or below the level of the soil underneath the structure (fig. 12, 13, 14) so that water is not trapped underneath the house and the foundation wall is exposed and can be inspected. Outside siding should not extend more than 2 inches (5 cm) below the top of foundation walls, piers, and concrete caps, and should be at least 6 inches (15 cm) above the outside grade. This will force termites into the open where their tunnels can be seen before they reach the wood. In crawl spaces the minimum clearance between the ground and the bottom of floor joists should be 18 inches (46 cm); such clearances for beams and girders should be 12 inches (30 cm) (fig. 14).

Termite shields—Metal termite shields (fig. 15) have been used to prevent hidden termite entry, particularly as a replacement for the concrete cap or other methods of sealing unit masonry foundations. If properly designed, constructed, installed, and maintained, shields will force termites into the open, revealing any tunnels constructed around the edge and over the upper surface of the shield. Experience has shown that very few shields are properly constructed and installed and that homeowners usually fail to inspect shields frequently enough to detect termite infestations. Therefore, termite shields are not presently recommended for detection and prevention of termite infestations.

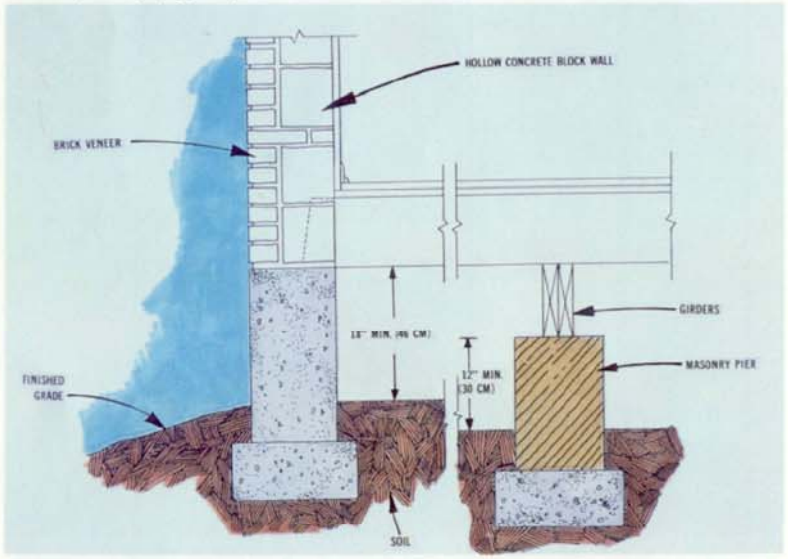

Figure 14. — Where the superstructure of a building is masonry, provide for adequate clearance between wood and soil both outside and inside the building.

Current research is aimed at the possibility of using certain plastics as shields. Termites tunneling over the shields, the need for frequent inspections, and improper construction and installation of shields are problems to be solved.

Ventilation beneath buildings—Ventilation openings in foundation walls beneath buildings with crawl spaces should be large enough and distributed so as to prevent dead air pockets from forming. Such pockets would give rise to humid conditions conducive to termite activity and wood decay. Openings placed within 10 feet (3 m) of the corners of buildings usually give the best cross ventilation. The openings need not be placed on the front side of a building if unventilated areas can be avoided. The size and number of openings depend on soil moisture, atmospheric humidity, and air movement. In general, the total area of ventilation openings should be equivalent to 1/150th of the ground area beneath dwellings. Shrubbery should be kept far enough from the openings to permit free circulation of air, and far enough from the foundation to allow inspection of wall surfaces for the presence of termite tubes.

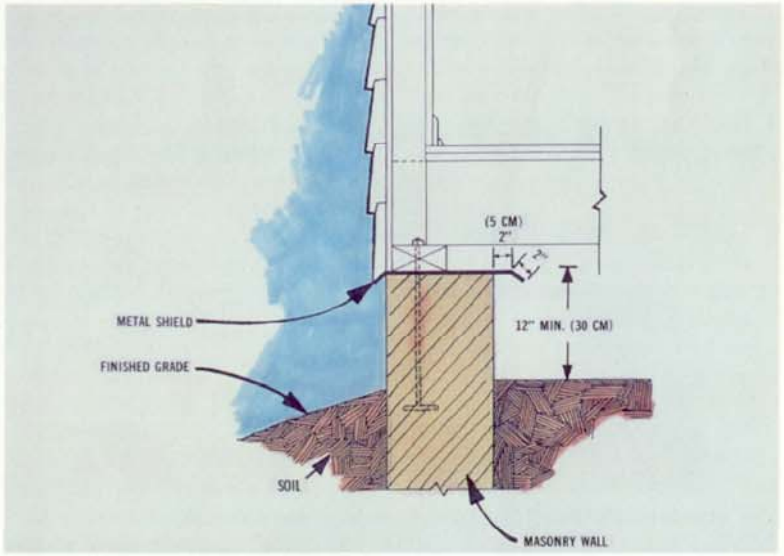

Figure 15. — Termite shield over uncapped masonry wall showing minimum clearance from ground on both inside and outside of foundation.

Exterior woodwork[1]—

Wooden porches and steps.—Porch supports, such as piers, adjacent to a building should be separated from the building proper by 2 inches (5 cm) to prevent hidden access by termites. Wooden steps should rest upon a concrete base or apron which extends at least 6 inches (15 cm) above the grade (fig. 16).

Door frames.—Door frames or jambs should never extend into or through concrete floors.

Windows below grade.—Where window frames or other openings near or below outside grade are made of wood, the foundation wall surrounding the wood should be made impervious to termites. The bottom of the window well should be at least 6 inches (15 cm) below the nearest wood.

Skirting between foundation piers.—Where pier foundations are used, it is sometimes desirable to close the spaces between the piers wih lattice or wooden skirting. If this is done, the woodwork should be separated from the piers and soil by at least 2 inches (5 cm).

[1]Certain units of exterior woodwork are susceptible to decay and should be treated with a preservative. For information on wood preservation see pages 29 and 30.

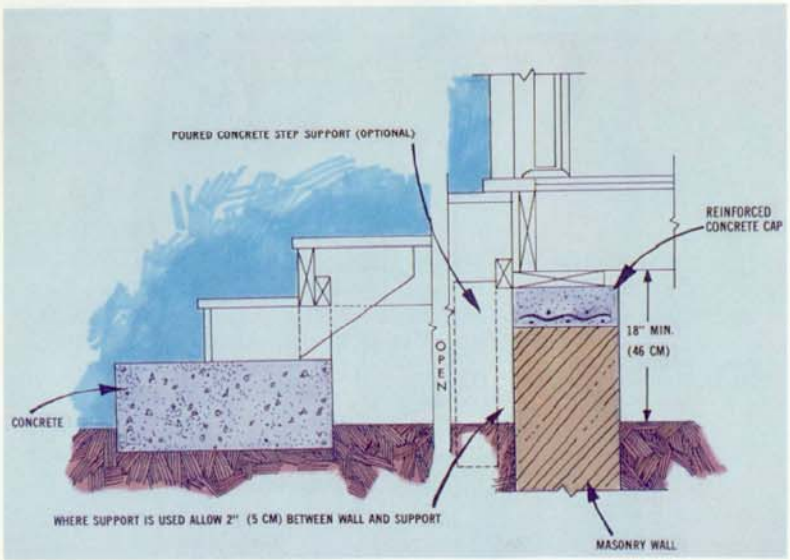

Figure 16. — Construction of wooden steps of porch to prevent hidden termite attack.

Wood used in basements—

Partitions and posts.—Install wooden basement partitions, posts, and stair carriages **after the concrete floor is poured**. They should never extend into or through the concrete. Concrete footings that extend at least 3 inches (8 cm) above the floor level should be used under wood posts, partitions, stair carriages, and under heating units and other load-bearing points. Use reinforced concrete because the concrete may crack, providing entrance points for termites.

Basement rooms. — Termite infestations in basement rooms are very difficult to detect and control. Such situations exist commonly in finished basements where untreated wood floors and furring strips are used. The best way to prevent such infestations is to treat the soil below the basement floor and along the outside of the foundation, preferably before the foundation and basement floor are constructed. Effective termiticides are discussed on page 23. Pressure-treated lumber should be used for wood screeds, subflooring, and furring strips because of the danger of decay (see pages 29 and 30).

Girders, sills, and joists. — Wooden girders, sills, and joists that are in or on foundation walls in basements should not be placed below the outside grade level. Termites may find hidden access to this wood and it may be subject to decay. Because of the difficulty of replacing girders, sills, and joists, it is a good practice to use preservative-treated lumber for these structural members. Termites generally will not eat wood treated with preservatives, but they will tunnel over treated wood to reach untreated wood.

Water pipes and conduits — Keep all plumbing and electric conduits clear of the gound in crawl spaces. Suspend them from girders and joists where possible. Do not support them with wooden blocks or stakes connected to the ground because termites will tunnel through these wood supports or construct tubes over them to the sills, floors, and joists above. Chemically treat the soil around plumbing extending from the ground to the wood above. Where pipes or steel columns penetrate concrete slabs or foundation walls, fill the spaces around them with either dense cement mortar or roofing grade coal-tar pitch after the soil around the pipe or column has been treated chemically. See pages 23–28 for treatment procedures.

Concrete slab-on-ground foundation — One of the most susceptible types of construction, and one that often gives a false sense of security, is the concrete slab-on-ground foundation. Termites can gain access to the building over the edge of the slab, through expansion joints, openings around plumbing, and cracks in the slab. Infestations in buildings with this type of construction are very difficult to control.

Because slab-on-ground construction is extremely susceptible to termite attack, and infestations are very difficult to control, **treat the soil with chemicals before pouring the concrete**. Such soil treatments, properly applied, will protect a building for many years and are much less expensive than remedial treatments at a later date. Foundations with sub-slab duct work should be treated by a professional pest control operator.

Do not leave any untreated wood such as forms, scraps, grade stakes, or wood plugs in or beneath the slab. Reinforce the slab at all points where it is likely to crack.

Termites can penetrate some types of slabs more easily than others. The **monolithic type** (fig. 17) provides the best protection against termites. In this type of construction the floor and the footing are poured in one continuous operation, eliminating joints or other structural features which permit hidden termite entry.

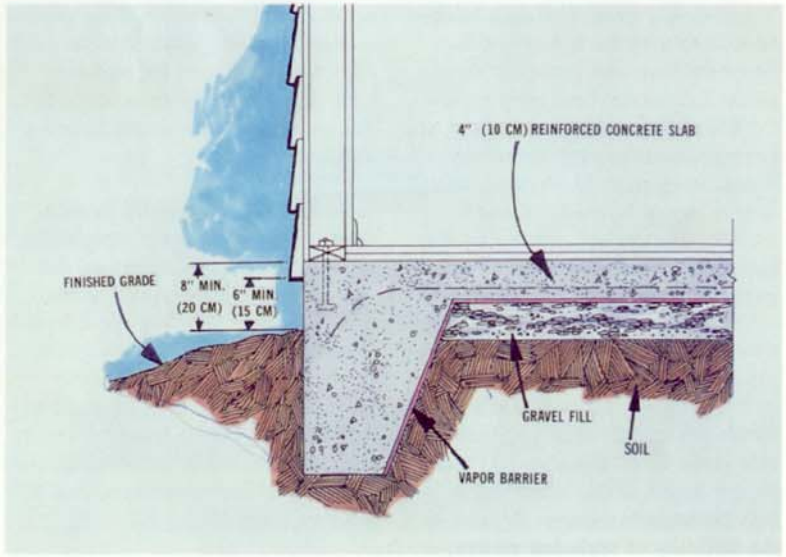

Figure 17. — Monolithic concrete slab-on-ground construction.

A second type is the **suspended slab** (fig. 18) which extends completely across the top of the foundation. Here the slab and the foundation are constructed as independent units. This prevents hidden termite attack because even though a vertical crack may develop in the wall, termites still must tunnel over an exposed part of the concrete slab. The lower edge of the suspended slab should be open to view. With the monolithic and suspended slabs, the top of the slab should be at least 8 inches (20 cm) above grade.

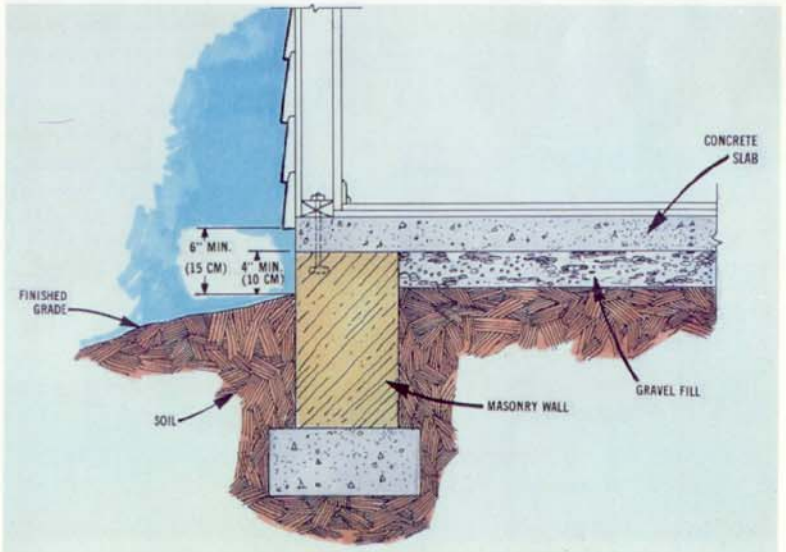

Figure 18. — Suspended concrete slab-on-ground construction.

A third type is the **floating slab** (fig. 19). It may either rest on a ledge of the foundation or be independent of it. In both instances the slab is in contact with the ground. This is the most hazardous of the three types of slabs because the slab edges come in contact with the foundation walls, and termites may gain hidden access to the wood through expansion joints.

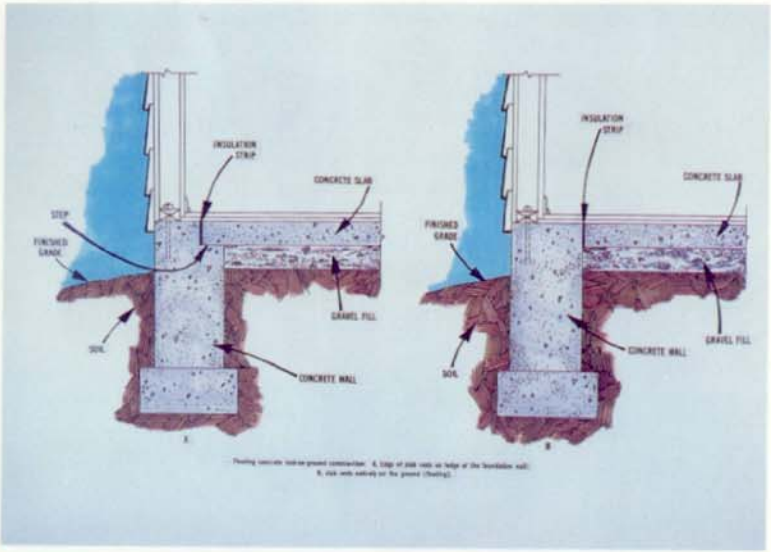

Figure 19. — Floating concrete slab-on-ground construction: (A) edge of slab rests on ledge of the foundation wall, (B) slab rests entirely on the ground (floating).

Direct control methods

Chemical treatment of the soil around and under the foundation is one of the prime methods of preventing termite attack. This should not be used as a substitute but should supplement good building practices. Chemically treated and naturally resistant woods can reduce the susceptibility of wooden structures to termite attack.

Chemical soil treatment — Insecticide-treated soil serves as one of the most important means of isolating a building from termites. Soil treatment is most effective when done before and during construction of the foundation. It is particularly important when using concrete slab-on-ground construction.

Several chemical formulations are registered with the Environmental Protection Agency for treating soils to prevent or control subterranean termite infestations. The termiticides currently most often used are: chlorpyrifos (Dursban® TC), cypermethrin (Demon® TC), fenvalerate (Tribute®), isofenphos (Pryfon® 6), and permethrin (Dragnet® or Torpedo®). All of these termiticides can be purchased by certified pesticide applicators and used under their supervision, but only chlorpyrifos can be purchased and used by homeowners in some States.

Preparation of chemical solutions. A soil chemical is economical and most easily prepared when purchased as a **liquid concentrate.** The concentrate is formulated according to the percentage, or weight in pounds per gallon, of the toxicant it contains. Each concentrate contains an emulsifier to make it mixable with water and *must be diluted before use.* Directions are given on the container for diluting the concentrated solution to the desired strength. The label should be followed carefully.

The recommended concentrations of the final dilutions are: chlorpyrifos, 1.0 percent; cypermethrin, 0.25 to 0.5 percent; fenvalerate, 0.5 to 1.0 percent; isofenphos, 0.75 percent; and permethrin, 0.5 to 1.0 percent.

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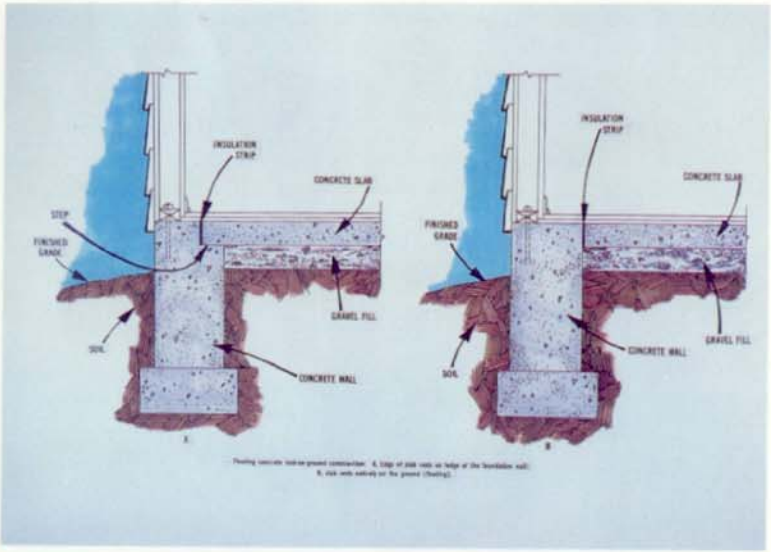

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Rates and methods of application. The objective of chemically treating soil is to provide a continuous barrier in soil surrounding the building foundation. The chemical must be applied thoroughly and uniformly to block all routes of termite entry. This requires that treatment be applied around all pipes and utility conduits that contact the soil or wood. Any of the previously mentioned termiticides is effective. The rates and methods of application vary with the type of construction and the area to be treated as follows:

1. ***Slab-on-ground construction.*** — This type of construction should be pretreated. Soon after the dirt or gravel fill has been put in place and tamped, treat the fill with the chemical **before the concrete slab is poured**. The chemical may be applied either with a power sprayer or a tank-type garden sprayer using low pressure to avoid misting.
   a. Apply 1 gallon (4 liters) of diluted chemical per 10 square feet (1 m^2) of area as an overall treatment under slab and attached slab porches, carport, garage, and terrace where the fill is soil or unwashed gravel (fig. 20).
   b. Apply 1.5 gallons (6 liters) of diluted chemical per 10 square feet (1 m^2) of area where the fill is washed gravel or other coarse absorbent material, such as cinder.
   c. Apply 4 gallons (15 liters) of diluted chemical per 10 linear feet (3 m) to the fill in critical areas under the slab, such as along the inside of foundation walls, along both sides of interior partition walls, and around plumbing.
   d. Treat voids in masonry blocks or foundations. If voids are inaccessible, drill holes near the footing and inject a chemical to form a continuous barrier. Apply 2 gallons (8 liters) of diluted chemical per 10 linear feet (3 m) of wall or foundation (fig. 21).

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Figure 20. — Chemical treatment of the fill material prior to pouring a concrete slab protects wood in the building from termite attack.

21

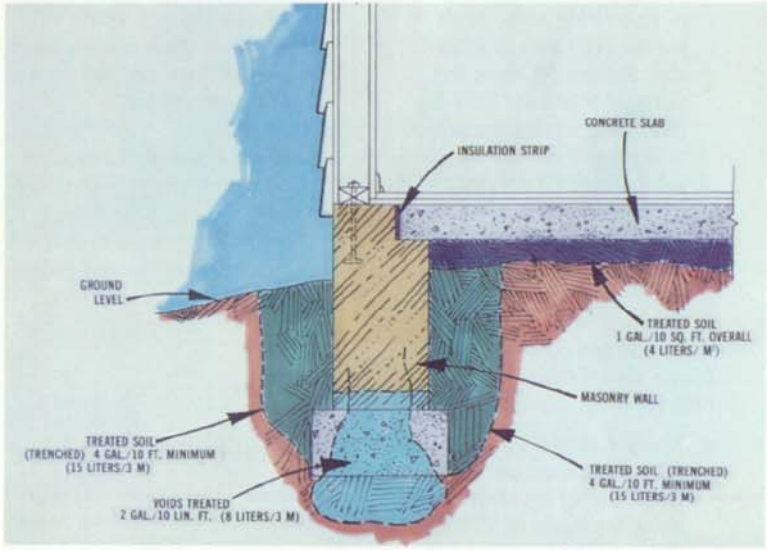

Figure 21. — Application of chemical to slab construction.

e. After the slab is poured, dig a trench 6 to 8 inches (15 to 20 cm) wide along the outside of the foundation including porches and patio (fig. 22). Where the top of the footing is more than 12 inches (30 cm) deep and where large volumes of chemical must be applied, make holes about 12 inches (30 cm) apart in the bottom of the trench to the top of the footing, using a crowbar, metal rod, or grouting rod. These holes will permit better distribution of the chemical by providing access to the soil at depths below the trench. The holes may need to be closer together in hard-packed clay soils than in light sandy soils. Apply 4 gallons (15 liters) of diluted chemical per 10 linear feet (3 m) of trench for each foot (0.3 m) of depth from grade to footing. Refill the trench and saturate the soil with chemical. Finally, place a thin layer of untreated soil on top of the treated soil.

2. ***Crawl-space houses.*** — The soil under and around crawl-space houses should be treated as follows:

   a. Apply 4 gallons (15 liters) of diluted chemical per 10 linear feet (3 m) of trench along the inside of all foundation walls (including porches and patio) and along all sides of interior supports and plumbing (fig. 23).

   b. Dig a trench 6 to 8 inches (15 to 20 cm) wide along the outside of the foundation including porches, patio, etc. Where the top of the footing is more than 12 inches (30 cm) below the surface, rod to the top of the footing (fig. 24). The holes may need to be closer together in hard-packed clay soils than in light sandy soils. Apply 4 gallons (15 liters) of diluted chemical per 10 linear feet (3 m) of trench for each 12 inches (30 cm) of depth from grade to footing. After rodding, refill the trench and saturate the soil with chemical. Then place a thin layer of untreated soil on top of the treated soil.

   c. Apply 1 gallon (4 liters) per 10 square feet (1 m^2) of soil surface as an overall treatment only where the attached concrete platform and porches are on fill or ground.

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Figure 22. — Application of a chemical to soil around the foundation.

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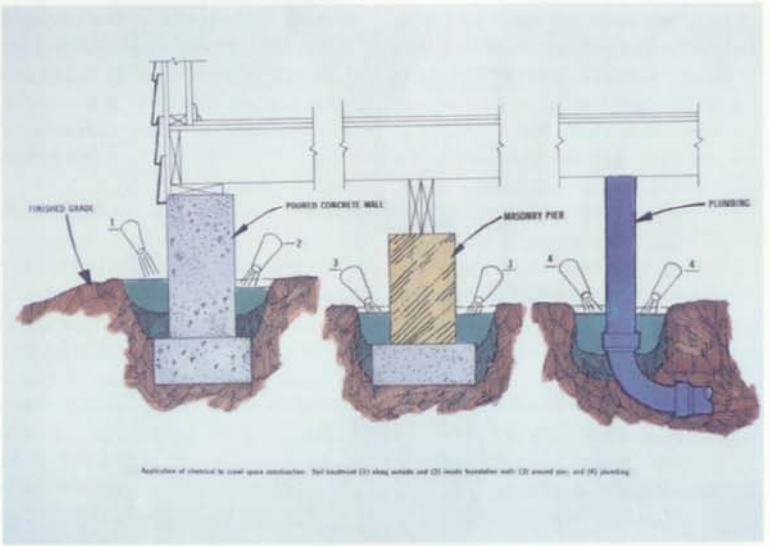

Figure 23. — Application of chemical to crawl-space construction. Soil treatment: (1) along outside and (2) inside foundation wall; (3) around pier and (4) plumbing.

3. ***Basement houses.*** —

a. Treat the soil under and around basement houses with chemicals applied in the same manner as recommended for slab-on-ground construction (fig. 24).

b. Voids in masonry foundations should be treated at or near the footing with 2 gallons (8 liters) of chemical per 10 linear feet (3 m) of wall.

4. ***Other types of construction.*** —

It is not possible to list in detail all the various types of construction available. However, treatments should be done according to the individual component parts, using the specifications which apply to each.

Considerations when treating new construction — The type of soil encountered at the building site and the amount of moisture present in the soil just prior to treatment will have an effect on the acceptance of liquids at the recommended rates. A soil fill will best accept a treatment when it is damp but not excessively wet or dry. If excessively wet, there is a chance of runoff, and the chemical will not penetrate the soil. In frozen or excessively dry soil the chemical solution is repelled and puddling occurs, resulting in poor distribution of the termiticide.

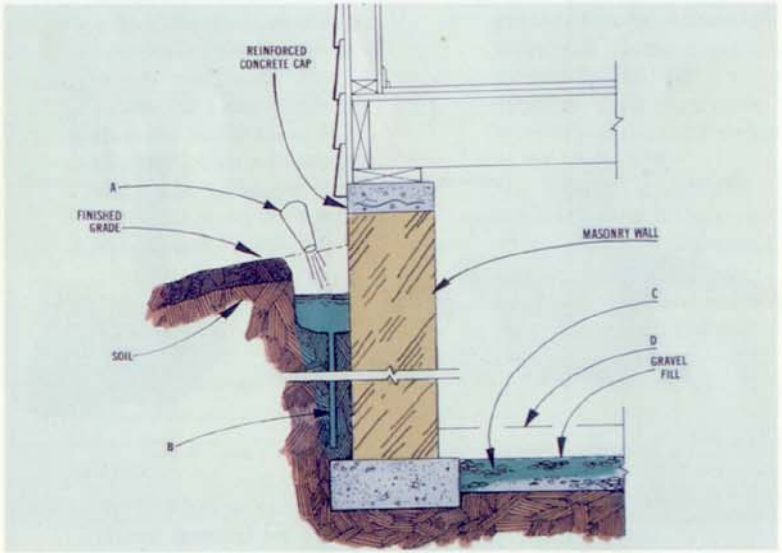

Figure 24. — Application of chemical to soil in and around a house with a full basement: (A) treatment along outside of foundation, (B) rodding from bottom of trench to top of footing, (C) treatment of fill or soil beneath a concrete floor in basement, (D) concrete slab poured after chemical has been applied.

Mechanical disturbance of treated soil breaks the continuity of the insecticide barrier and increases the possibility of termite penetration. The treatment of fill under slabs is probably less than 2 inches (5 cm) deep and the majority of the material is in the top 0.75 inch (2 cm); therefore very little disturbance to the treated soil can be tolerated. The final treatment on the ouside of foundation walls should be done **after all grading and other soil disturbance has been completed**. A freshly treated slab foundation site should be protected with a polyethylene sheet or other waterproof material, unless the concrete is to be poured the day of the treatment. This will prevent rain from washing away the insecticide or treated soil.

The termiticide is stable once it dries on the soil. Because the most commonly used termiticides are insoluble in water, leaching is not a problem. However, there is a slight risk of contaminating a well or other water supply if insecticides are applied to nearby soil that either contains layers of gravel or tends to severely crack during periods of drought. In these situations, the soil should not be treated with chemicals.

Naturally resistant woods — Untreated sapwood is usually highly susceptible to termites and has a short service life when termites are allowed access to it. However, the slow-growing heartwood of some wood species has varying degrees of termite resistance. This resistance is attributed to chemical components that are toxic and/or repellent to termites. The practice of using resistant woods in construction has been almost completely replaced in the United States by using chemicals to protect wood.

Precise ratings for termite resistance of heartwood are not possible because of differences within wood species. However, some of the most resistant species are: baldcypress, eastern red cedar, chestnut, Arizona cypress, black locust, redwood, osage orange, black walnut, and Pacific yew. It should be noted that **even the most resistant wood cannot be considered a termite barrier**. Termites are able to tube over resistant wood to attack susceptible wood. Only those parts actually constructed from such wood can be considered resistant. Generally, the use of resistant wood throughout a structure can be economically justified only when drywood termites and decay are considered serious problems and protection from them is necessary.

Chemically treated woods — Chemically treated wood safeguards against both termites and decay. The degree of protection obtained depends on the kind of preservative, the penetration achieved, and the retention of the chemical in the wood.

Control of subterranean termites in existing buildings

There is a difference in the treatability of various species and types of wood, and heartwood resists treatment more than sapwood.

The life of wood structures can often be increased five times by applying wood preservatives at standard retention rates and assuring that the wood is satisfactorily penetrated. For maximum protection, the wood should be pressure-impregnated with an approved chemical by a standard process. In less severe conditions, a vacuum treatment usually gives adequate protection. Brush, spray, or short-period soak treatments only give limited protection of wood above ground and should not be relied on to give long-term protection from termite attack.

Wood preservative chemicals and their uses are given in: (1) Federal Use Specification TT-W-571J, (2) Standard T1–49 of the American Wood Preservers Association, and (3) Standards of the National Woodwork Manufacturers' Association. As with the naturally resistant woods, termites are usually able to tube over chemically treated wood and attack untreated wood. Again, only where drywood termites and decay are major concerns should chemically treated wood be used throughout a structure.[2]

[2]Minimum Property Standards for One- and Two-Family Dwellings, HUD Manual 4900.1.

Ridding existing structures of termites and making them resistant to future infestation are major problems in termite control. Generally, buildings become infested because little or no attention was given to the preventive measures during construction that would have made the structures resistant to termites. It is in such buildings that termites cause heavy losses each year.

When controlling termites in existing buildings, observe the same principles that are recommended for the prevention of infestations during the construction of new buildings. That is, eliminate conditions favoring the development of termite colonies in the soil and permitting passage of termites to the wood within the building. Subterranean termites in the wooden parts of a building will die if they are unable to maintain contact with the soil or another source of moisture.

Inspection

Wooden structures that are in areas where subterranean termites occur should be inspected periodically for evidence of active infestation regardless of previous preventive measures. If no preconstruction measures were employed, the structure should be inspected more frequently. The best physical barriers can be breached by termites, and under certain circumstances, even insecticides may be ineffective in stopping termites. The continuity of the chemical barrier may be broken, and maintenance or repair personnel may leave a termite-prone condition after working underneath or around the structure. Even the homeowner can inadvertently disturb the treated soil or place wood on the soil against or under the building. If not cautious, the homeowner may overlook vegetation that has grown over or through the chemical barriers, providing access for termites. Settlement cracks may occur in foundation walls or concrete slabs and allow termite entrance.

With proper inspection, usually annually, very little termite damage should result before discovery. Termites typically work slowly and can be detected and controlled before causing structural weakness to the timbers. Although extreme haste is not required, **once an infestation is discovered, treatment should be applied within a few months.**

Sanitation

Sanitation and structural control measures should be given consideration in the control of existing infestations. In addition to chemical treatments, the following control measures should be used:

1. Remove all wood, including formboards and other debris containing cellulose, from underneath and adjacent to buildings with crawl spaces.
2. Remove exterior wooden structures, such as trellises, that connect the ground with the woodwork of the building. Any wood remaining in contact with the soil should be treated with preservative.
3. Replace heavily damaged (structurally weakened) sills, joists, flooring, etc. with sound wood. Where possible, remove all soil within 18 inches (46 cm) of floor joists and 12 inches (30 cm) of girders (fig. 13).
4. Fill voids, cracks, or expansion joints in concrete or masonry with either cement or roofing-grade coal-tar pitch.
5. Provide adequate drainage (see page 14).
6. Provide access for inspection of vulnerable areas (see page 15).
7. Provide adequate foundation ventilation. In some cases, a moisture barrier (polyethylene or similar material) placed on the soil can be used instead of providing additional ventilation.

Chemical control

Chemicals used to prevent subterranean termite infestations are also used to control existing infestations in buildings. The recommended chemicals, concentrations, rates of application, method of preparation, and necessary precautions are discussed on pages 23–28.

The many variations in construction prevent a detailed discussion of exact procedures for chemical treatment in all situations. However, in applying treatments, remember that **the purpose is to establish a chemical barrier between termites in the soil and wood in the structure.** Some

procedures for treatment of existing buildings are as follows:

1. ***Slab-on-ground construction.*** — Termite infestations in buildings with a slab on the ground present serious control problems. It is difficult to form an effective chemical barrier in the soil beneath such floors. One way to treat under the slab is to drill a series of vertical holes about 0.5 inch (1.2 cm) in diameter through the slab, particularly at the base of partition walls and other points where the termites may be entering (fig. 25). The distance between holes is determined by the type of soil or fill material and its moisture content. However, in most cases 18 inches (46 cm) is recommended. Because a complete barrier is necessary for the treatment to be effective, the chemical injected into each hole must meet with that injected in adjacent holes. The advantage of vertical drilling and injecting is that the chemical will flood and cover the surface of the soil.

Another way to treat under slabs is to drill horizontally through exterior foundation walls to the soil just beneath the slab and inject the chemical in the holes. This method is complicated, requires special equipment, and should only be performed by a professional pest control operator. Extreme caution should be taken to prevent drilling into plumbing, electric conduits, or heating ducts that may be imbedded in concrete. **Injection of termiticides into these areas must be avoided.** Always treat along the outside of the foundation (see page 26).

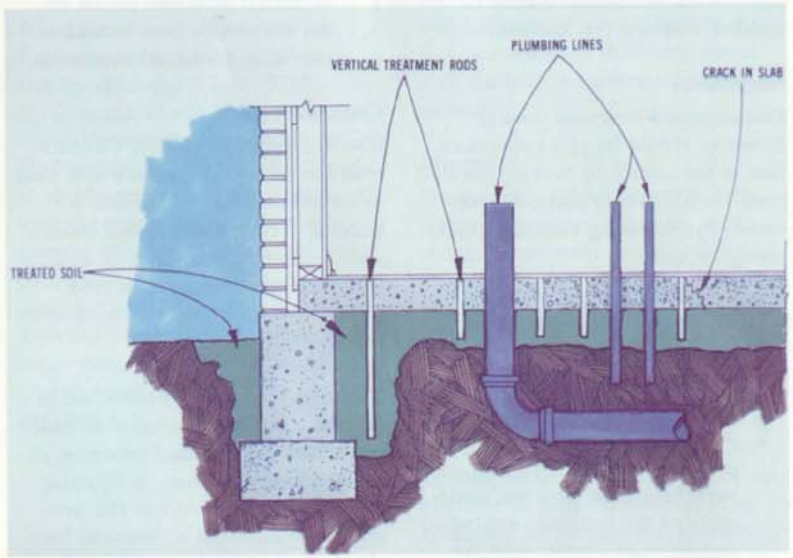

Figure 25. — Treatment under concrete slab with vertical rodding at joints, cracks, and openings around plumbing.

2. ***Crawl-space construction.*** — Buildings with crawl spaces usually can be treated easily and effectively. The procedures recommended for pretreatment can also be used for termite control in existing buildings (see page 26).
3. ***Basement construction.*** — Treat the soil along the outside walls of basements (see page 28).
4. ***Raised porches, terraces, and entrance slabs.*** — Termite infestations frequently occur at porches, terraces, and entrance platforms. The most satisfactory way to control infestations at these locations is to excavate the soil adjacent to the foundation wall, remove all wood debris, and apply a chemical to the soil as recommended. Place an access panel over the opening to permit inspection. Alternatively, holes may be drilled either through the adjacent foundation wall from within the crawl space or basement, or through the entrance slab. Chemicals should be injected to form a continuous barrier.
5. ***Buildings with wells.*** — Where wells are located close to or within foundation walls, the same principles of termite control apply as are recommended for their prevention. However, greater care must be exercised when using chemicals to form a barrier. Although the presently recommended termiticides are not very water soluble once they have dried on the soil, treated soil can be physically moved so as to carry the chemical into the well.

Other insects that damage wood in buildings

Other insects attack wood in buildings, and their damage may be mistaken for that caused by subterranean termites. The insects most commonly involved are drywood termites, wood-destroying beetles, carpenter ants, and carpenter bees. The work of these insects differs from that of subterranean termites in that the wood they attack is converted to either compressed pellets, powder, or shredded fibers. In contrast, subterranean termites leave small, grayish-brown specks of excrement in excavated areas. Subterranean termite galleries follow the grain of the wood, whereas the tunnels of most of the other insects mentioned usually cut across the grain.

Precautions for use of pesticides

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers – out of reach of children and pets – and away from foodstuffs.

Apply pesticides selectively and carefully. Do not apply a pesticide when there is danger of drift to other areas. Avoid prolonged inhalation of a pesticide spray or dust. When applying a pesticide it is advisable that you be fully clothed.

After handling a pesticide, do not eat, drink, or smoke until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If the pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Dispose of empty pesticide containers by wrapping them in several layers of newspaper and placing them in your trash can.

NOTE: Registrations of pesticides are under constant review by the Federal Environmental Protection Agency. Use only pesticides that bear the EPA registration number and carry directions for home and garden use.

Checklist for termite problems

1. Cracks in concrete foundation. These give termites hidden access to your house.
2. Posts in concrete. If they go all the way through the concrete to the soil underneath, they invite termite attack.
3. Earthfilled porches. Soil should be at least 6 inches (15 cm) below the level of any wooden members.
4. Formboards. If left in place after construction is completed, they provide excellent termite food.
5. Leaking pipes or faucets. They keep the wood or soil underneath continually moist.
6. Shrubbery near air vents. Anything that blocks air flow causes air underneath house to remain warm and moist — an ideal climate for termites.
7. Debris under and around house. Pieces of wood support a termite colony and permit termites to increase in number to the point that the home is eventually attacked.
8. Low foundation walls or footings. These permit wooden members to contact the soil.
9. Brick veneer covering foundation. If bond fails, termites have hidden entrance between exterior and foundation.
10. Flower planters. If built against the house, they allow direct access to unprotected veneer, siding, or cracked stucco.
11. Wooden forms around drains. Forms left in a hole in the slab where a drain enters the building provide a direct route to inner walls.
12. Porch steps on ground. Steps in contact with soil literally offer termites a stairway to your home.
13. Area around heating unit. Soil here is kept warm year-round, which accelerates termite development.
14. Paper collars around pipes. Paper is made of wood, which is the termite's food source.
15. Trellises. If a trellis touches the soil and is connected to the house it provides a direct link for termites from soil to wood.

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