
Effective Termite Protection for Multi-Family & Commercial Wood Buildings

Techniques for Keeping Wood-Frame Buildings Pest-Free

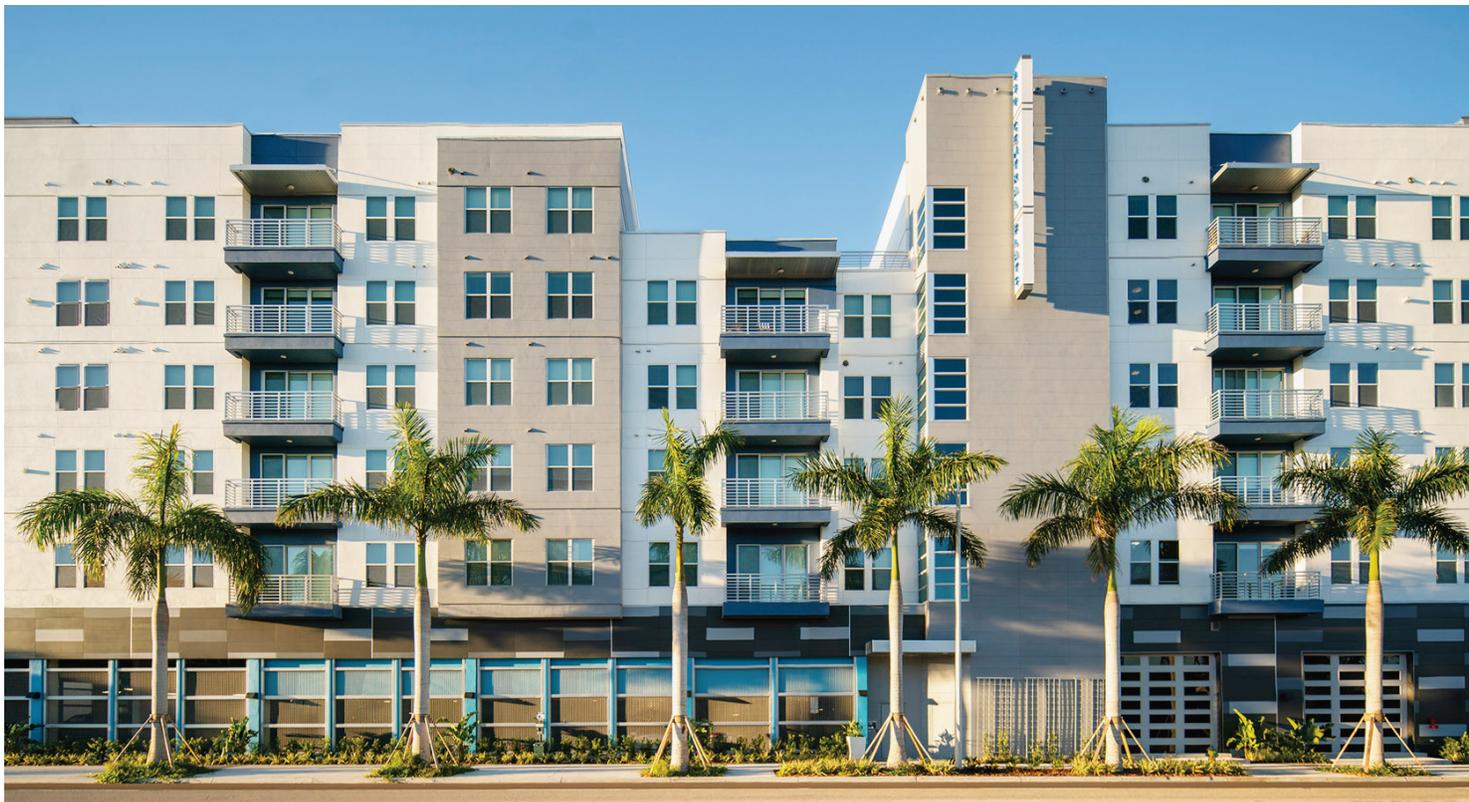
Wood-frame construction is a good choice for commercial and multi-family buildings, even in states where termites pose a higher risk. Wood buildings are safe, economical and sustainable. With the right precautions, they're also durable and insect resistant. That includes proper design and detailing, good construction practices, and a pest management strategy that involves pesticides and/or physical barriers. Where termites pose a risk, it is good practice for the general contractor to engage a pest control specialist during pre-construction to map out an appropriate plan.

According to Faith Oi, PhD, Director of the University of Florida's Pest Management University, the key to effective termite prevention is making the building inhospitable to termites. "Subterranean termites, which are the most

damaging and economically important species in the U.S., follow pheromones and physical guidelines such as the outside of foundation walls. They can use any gap as a pathway—so it's important to minimize hidden access and treat critical areas."

This paper focuses on how to design and construct wood-frame buildings for termite prevention, and how to keep buildings insect-free over the long term. Intended for developers and design/construction teams, it covers building code requirements, best practices, control methods, costs, and ongoing maintenance. It emphasizes subterranean termites (including Formosans), and briefly covers drywood termites and other insects with the potential to cause damage.

Photo: Charlan Brock Architects



What the Codes Say

Insect infestation is a common but avoidable threat in most parts of the country. Termites pose a particular risk, to the point that building codes include provisions for their prevention, but carpenter ants, powder post beetles, and other wood-boring pests can also cause damage.

Termite requirements are included in the International Building Code (IBC), International Residential Code (IRC), state codes, and local codes and ordinances. Wording varies, but codes often cover similar ground, including required pest control tactics, the use of licensed companies, contracts, notices of treatment, inspection, and certificate of compliance. Some requirements are based on level of risk—e.g., the IBC refers to “geographical areas where hazard of termite damage is known to be very heavy” regarding the treatment of wood floor framing. The map shown in Figure 1 is used as a guide.

Building code requirements go a long way toward preventing termites in a building. For example, Section 2304.12 of the 2018 IBC requires the use of preservative-treated wood or naturally durable wood in certain locations, as described below. Preservative treatment in the IBC refers to pressure treatment as opposed to surface treatment (e.g., spraying or brushing). For clarity, the term pressure-preservative-treatment is used in this paper.

In the following locations, wood must be treated using waterborne preservatives in accordance with the American Wood Protection Association standard AWPA U1 for above-ground use, or of naturally-durable species:

- **2304.12.1.1 – Joists, girders and subfloor**
Wood joists or wood structural floors that are closer than 18 inches or wood girders that are closer than 12 inches to the exposed ground in crawl spaces or unexcavated areas located within the perimeter of the building foundation
- **2304.12.1.2 – Wood supported by exterior foundation walls**
Wood framing members, including wood sheathing, that are in contact with exterior foundation walls and less than 8 inches from exposed earth
- **2304.12.1.3 – Exterior walls below grade**
Wood framing members and furring strips in direct contact with the interior or exterior masonry or concrete walls below grade
- **2304.12.1.4 – Sleepers and sills**
Sleepers and sills on a concrete or masonry slab that is in direct contact with earth
- **2304.12.1.5 – Wood siding**
Wood siding that is less than 6 inches from the earth, or less than 2 inches vertical from concrete steps, porch slabs, patio slabs and similar horizontal surfaces exposed to the weather



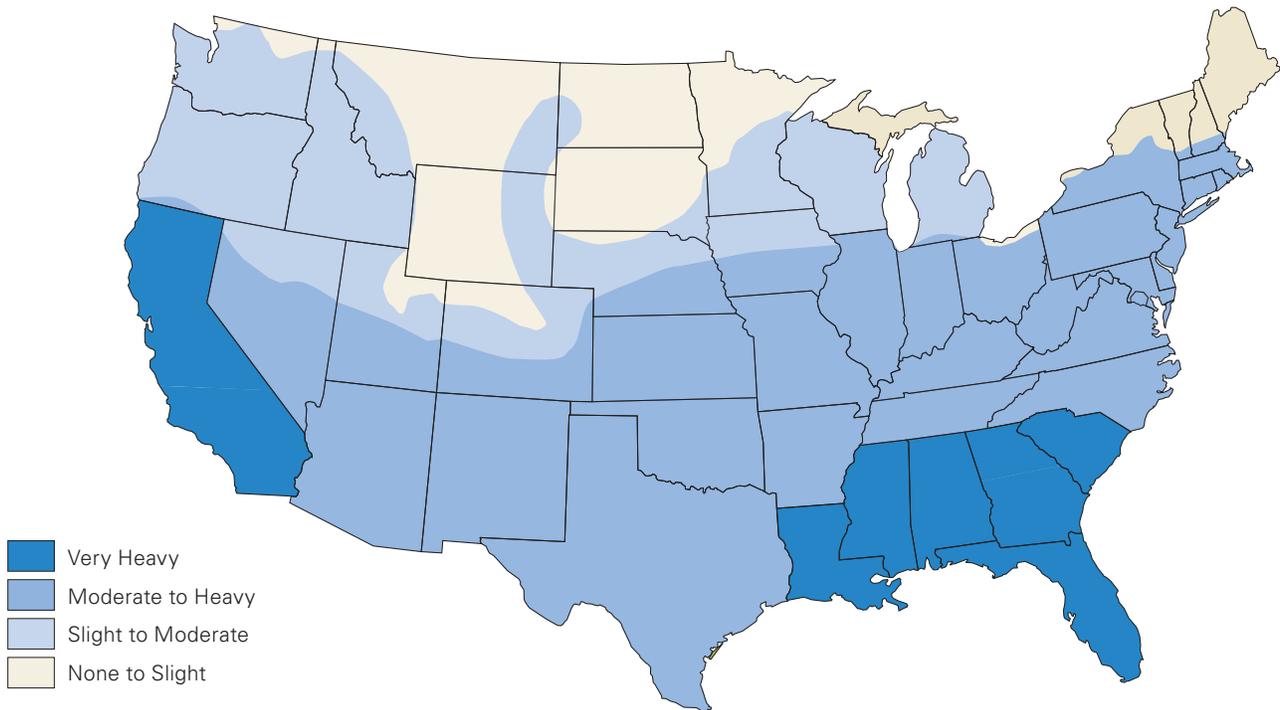
District Flats in Charlotte, NC includes five stories of wood-frame construction over a concrete podium.

FIGURE 1:

Termite Probability Map

Relative hazard of subterranean termite infestations in the United States

Source: 2018 IBC Figure 2603.8



Understanding the Threat: Termite Facts

Worldwide, there are more than 2,000 termite species. Forty-five can be found in the U.S., and termites are present in all states except Alaska. Species fall into three main categories:

- **Subterranean termites** – The biggest threat to buildings, but controllable; Formosan and Asian subterraneans can be especially damaging and require extra vigilance in the southeast, California, and Hawaii
- **Drywood termites** – Found primarily in southern coastal areas and Hawaii; some species can be found in furniture and are considered to have worldwide distribution
- **Dampwood termites** – Primarily in the Pacific Northwest; rarely an issue for buildings because of the degree of wetness they require

A fourth category, higher termites, requires caution in Florida. Sometimes called coneheads, these termites make nests in trees and don't need soil access to a structure. This makes them easier to find and remove than other species.

Subterranean termites need three things to survive: food, moisture and habitat. Damp wood conditions are ideal, so these termites are often found near leaking pipes, roof gutters, and wood kept moist by run-off water or poor site

drainage. Colonies are usually found in wood that's in contact with soil, but can also be found in wood well above ground where there's a moisture source.

To enter a building, subterranean termites use a system of galleries in the soil and mud (or shelter) tubes above ground. They can pass through cracks as small as 1/16-inch in concrete or any part of a building that isn't edible (e.g., steel, glass, composites). Mud tubes are made of soil, wood fragments, and bodily secretions.

Damage is not restricted to wood or cellulose-based components; termites have been known to chew through cable shields, plastic laminates and foam insulation. They also aren't limited to structural wood components—they'll damage kitchen cabinets, storage boxes, books, and the surface of drywall. Formosan colonies have been found on the top floors of concrete high-rises in Hawaii and Miami!

Swarming termites aren't the ones doing damage. The presence of adult, winged termites, known as swarmers, is a signal that a colony is in the area and it's time for an inspection. The role of swarmers is to look for a suitable location to start a new colony. It's the workers *in the colony* doing the harm.

In the following locations, any treated wood that complies with the AWPA U1 standard may be used. However, treated wood in interior locations must be protected with two coats of urethane, shellac, latex epoxy, or varnish unless waterborne preservatives are used.

- **2304.12.2.1 – Girder ends**
Ends of wood girders entering exterior masonry or concrete walls, unless they have a 1/2-inch airspace on top, sides and end
- **2304.12.2.2 – Posts or columns**
Posts or columns supporting permanent structures and supported by a concrete or masonry slab or footing in direct contact with the earth, unless they meet all of the following criteria: they are not exposed to the weather or they're protected by a roof, eave, overhang or other covering; they are supported by concrete piers or metal pedestals projected not less than 1 inch above the slab or deck and are separated from the concrete pier by an impervious moisture barrier; and they are located at least 8 inches above exposed earth
- **2304.12.2.3 – Supporting member for permanent appurtenances**
Supporting members for balconies, porches and other permanent appurtenances where they are exposed to weather without adequate protection, except in geographic regions where climatic conditions preclude the need to use durable materials in these conditions
- **2304.12.2.4 – Laminated timbers**
Structural glulam members that are exposed to weather and not fully protected from moisture
- **2304.12.2.5 – Supporting members for permeable floors and roofs**
Wood structural members that support moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, unless separated by an impervious moisture barrier
- **2304.12.2.6 – Ventilation beneath balcony or elevated walking surfaces**
Enclosed framing in exterior balconies and elevated walking surfaces that are exposed to rain, snow or drainage from irrigations; these areas must also include openings that provide a net free cross-ventilation area not less than 1/150 of the area of each separate space

In the following locations, treated wood must comply with AWPA U1 for soil and fresh water use:

- **2304.12.3 – Wood in contact with ground or fresh water**
Where wood is in contact with exposed earth, unless the wood is continuously and entirely below the ground-water level or submerged in fresh water; includes posts and columns embedded in concrete that is exposed to the weather or in direct contact with the earth



Pressure-preservative-treated wood used as sill plates. The IBC requires that surface treatments be applied to end cuts and holes.

Photo: Western Wood Preservers Institute

- **2304.12.5 – Wood used in retaining walls and cribs**

In geographical areas where hazard of termite damage is known to be very heavy, Section 2304.12.4 also requires that wood floor framing in locations specified in Section 2304.12.1.1 and exposed framing of exterior decks or balconies be of pressure-preservative-treated wood in accordance with AWPA U1 for the species, product preservative and end use or provided with approved methods of termite protection.

Attic ventilation and under-floor (crawl space) ventilation are also addressed in Sections 1202.2.2 and 1202.4, respectively.

Although it isn't the guiding code for commercial and multi-family buildings, the IRC is a good reference for termite prevention strategies. For wood-frame buildings in high-risk areas, Section R318.1 requires the use of at least one of the following:

- Chemical termiticide treatment
- Termite baiting system
- Pressure-preservative-treated wood
- Naturally durable termite-resistant wood
- Physical barrier

Where requirements are contradictory, the local building code has ultimate authority. The state's lead pesticide agency typically regulates pesticide use and other activities undertaken by a pest control company (e.g., allowable chemicals, application, etc.).



Preservative-treated wood

Photo: Dreamstime

Design & Detailing for Moisture

Subterranean termites thrive in moist environments, so designing and detailing the building for proper moisture control is crucial. However, the question of moisture goes beyond termite protection. If you're designing a wood-frame building in an area prone to termites, especially in southern U.S. states, moisture control is a priority for many reasons.

Best practices fall into four main categories: deflecting water, separating untreated wood from soil and other moisture sources, site and building drainage, and drying (i.e., air movement and vapor diffusion). Examples include:

- Sizeable roof overhangs and water collection systems at the roof perimeters
- Architectural detailing, including flashing and caulking, that directs water away from the building
- An approved drainage system around the foundation perimeter to accept roof water run-off
- A weather barrier within the walls, appropriately positioned, with vapor permeability suitable for the climate and moisture management approach
- Permeable bulk vapor diffusion retarders on the exterior of walls and floors, including below a concrete slab or on top of the bare soil within a crawl space
- Impermeable membranes separating wood elements from moisture elements, including soil and concrete

The American Wood Council (AWC) publication, *Design of Wood Frame Structures for Permanence* (WCD6), and e-course, *Design Considerations of Wood Frame Structures for Permanence* (DES125), describe best practices for water management in wood-frame buildings and provide details for protecting buildings from moisture over the long term.

Integrated Pest Management

An integrated approach that combines multiple termite control tactics is key to making the risk of infestation negligible.

Termite-Resistant Materials

As noted, the IBC requires that wood used in certain applications be preservative-treated in accordance with the AWPA U1 standard for above-ground use, or made from naturally-durable species. Preservative treatment in the IBC refers to pressure treatment as opposed to surface treatment (e.g., spraying or brushing).

Pressure-preservative-treated wood products are typically treated with borate or copper-based preservatives, both of which effectively protect wood from termites and decay. Borate is water soluble and can lose its effectiveness when exposed to liquid moisture. As such, AWPA standards allow borate-treated wood to be used only in interior applications that are dry or exposed to occasional dampness. Copper-based treatments are not water soluble, and are used where wood will be exposed to the elements.

Maintain Minimum Clearance: Don't Miss This Simple but Effective Tactic

Building codes offer effective measures for reducing the risk of insect infestation, but it is common for some requirements to fall by the wayside over time.

For example, making sure that wood framing members and sheathing that rest on exterior foundation walls are a minimum of 8 inches from exposed earth is one of the simplest and most effective termite-prevention tactics. However, soil, mulch, and sod often get pushed against the building when a site is graded after construction—and stay that way. This creates a moist, welcoming environment for subterranean termites, while giving them an opportunity to build shelter tubes and access the structure unseen. It also prevents a proper view of the foundation perimeter, which is needed for inspection. Making the environment inhospitable to termites is the best way to achieve a termite-free building.



Apartment building in Dallas, TX

Pressure treating allows the preservative to penetrate the sapwood, increasing its resistance to termites. However, when treated wood is cut or drilled on site, building codes require that surface treatments be applied to cut ends and holes. These field treatments must contain copper naphthenate or oxine copper for exterior applications or borates for interior applications, as defined in AWPA Standard M4. Although not included in the IBC, termite treatment solutions can be sprayed onto the entire structure just before the drywall is installed for additional protection. (See In-Structure Barrier on page 8.)

Guidance on specific applications for pressure-preservative-treated and naturally durable wood can be found in the AWC's WCD6 noted above. In applications where fire retardant-treated wood (FRTW) is required, such as exterior walls in Type III buildings, some manufacturers offer products that are also resistant to termites and decay.

Building codes require specific fasteners for pressure-preservative-treated wood. Nails, screws, and other fasteners used with copper-based treatments must be hot-dipped galvanized, stainless steel, silicon bronze or copper, which protect against corrosion caused by the interaction between the copper in the preservative and steel in the fastener.² Most borates formulated for termite protection are inorganic salts and will not interact with the metal in fasteners. Thus, codes allow the use of plain carbon steel fasteners with borate-treated products. Given the tremendous range of fastener coatings available, AWPA recommends following the fastener manufacturer’s recommendations regarding compatibility with treated wood.

To assist architects and engineers, the Western Wood Preservers Institute (WWPI) offers a guidance document, *Specifying with AWPA Use Categories for Construction*.³ Use Categories are described in AWPA’s U1 Standard and numbered according to the risk of the application—i.e., UC1 for interior dry conditions through UC4B for ground contact, heavy duty conditions. The higher the number, the greater the risk and the more treatment required in the wood.

Wood products treated to UC1 (interior, dry) and UC2 (interior, damp) are used to protect against termites in interior applications, such as sill plates and framing. AWPA standards define two levels of borate treatment—a lower loading for native subterranean termites and a higher loading for areas where there may be Formosans. In areas where there is a high risk of Formosans, local building codes require additional protection. In Hawaii, for example, the state code requires all wood framing to be pressure treated with borates to a UC1 or UC2 Formosan-level of protection. Other than degree (e.g., more vigilance or pesticides), approaches for protecting against Formosan termites are generally the same as those for other subterraneans.

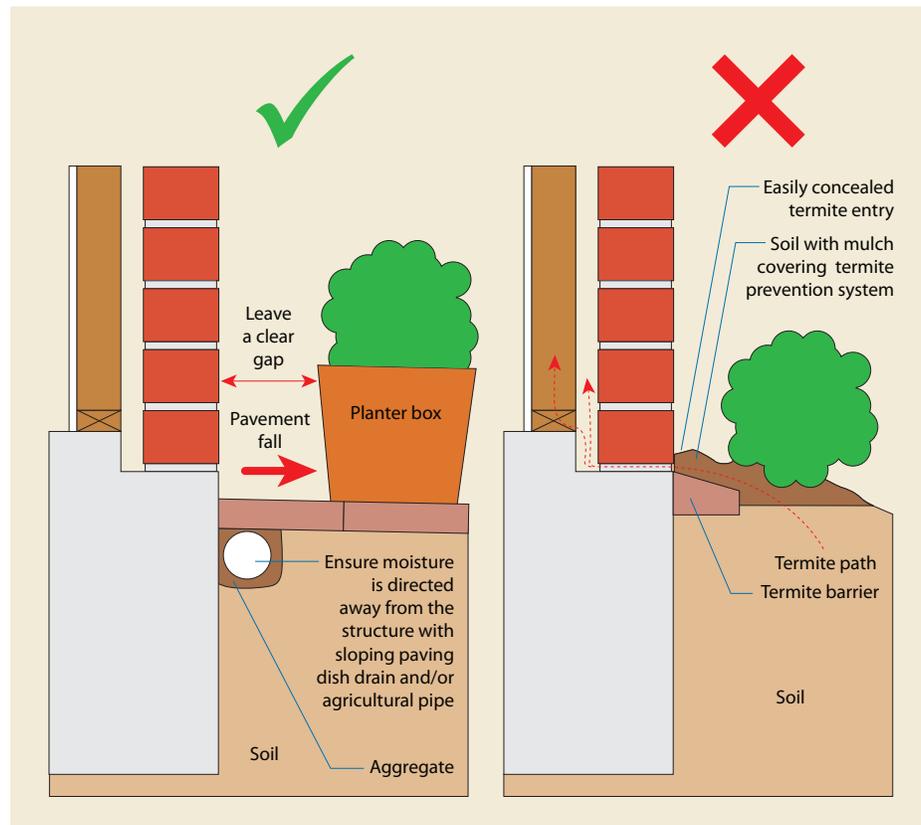
Termite-resistant wood species include the heartwoods of redwood and cedar. Heartwood comes from the center of the tree and contain tannins and other extractives that discourage insects and decay. Designers looking for naturally durable species should specify “all heart” grades.

Site Management

Proper site management begins before clearing and continues through construction.

- Remove stumps, roots and any buried untreated wood. (Many construction teams do this as part of regular site prep unrelated to termites.) Stumps provide food and shelter for colonies and roots offer pathways underground that could lead termites to the structure.
- Cover and wrap construction materials that are stored on site, making sure to keep non-treated wood a minimum of 6-8 inches away from soil.
- Remove concrete form boards and dispose of them off site.
- Remove offcuts and other wood construction debris on a regular basis (including debris in CMU block cells if being used).
- Drain water away from the building at a slope of 5% per 10 feet.
- Don’t use excavation spoil under wood-frame elements.
- Don’t store cellulose-based materials such as wood or cardboard in crawlspaces.
- Close the building in as soon as possible.

Post-construction, once landscaping is complete, another check should be done to make sure the required clearance is maintained.



Termiticide Soil Barriers

Termiticide soil treatment—before and after construction—is a common method of termite control. It is also highly effective.

Initial treatment is applied before work begins on the slab (or footings in the case of a crawlspace). The site is treated with termiticides according to the product label—e.g., 1 gallon per 10 square feet—focusing on the soil in and around the excavated area where the slab will be poured, and pipe beddings. Labels often refer to “treated zones,” which may be continuous, the effect being to create a barrier between the soil and structure.

After the slab is poured and the form boards have been removed, termiticides can be applied vertically to the soil against the foundation walls. However, concrete overpour or mortar that’s accumulated along the exterior foundation perimeter should be removed before treatment. Another treatment may be applied around the outside foundation wall once landscaping is complete. In most jurisdictions, a pest management professional is required to issue a certificate of compliance to the building department following treatment.

Although pest companies are well-versed in termite control, the GC is expected to be aware of the requirements. For example, the Florida Building Code includes several requirements for avoiding displacement of the chemical termiticide after soil treatments:

- Spaces boxed out or formed in concrete floors for the installation of plumbing traps, drains or other purposes must be made of plastic or metal, be permanently placed, and be positioned deeply enough to eliminate any soil disturbance after the initial soil treatment.
- A minimum 6 mil vapor barrier must be used to protect against rainfall dilution.
- Any work done after the treatment and before the slab is poured should be undertaken in a way to avoid penetrating or disturbing treated soil.

Whether or not these are code requirements in a given jurisdiction, they are best practices for the use of termiticide soil barriers.

As with all termite-prevention tactics, there are limitations to soil termiticide treatment that make it important to follow label instructions and requirements for maintenance. For example, the efficiency of a soil barrier depends on soil type and other factors, foundation drains could make it difficult to apply the treatment, and treatments should not be used near a well or cistern unless the soil is excavated, treated and replaced.

Physical Barriers

Installed during construction, physical barriers are intended to prevent termites from accessing a structure unseen. To breach the barriers, termites are forced to build their shelter tubes above ground, making it easy to detect and remove threats.

Physical barriers are less common and more costly than chemical barriers, and add a degree of difficulty to the construction process. However, they offer an effective, environmentally-friendly option. The use of physical barriers and other non-toxic approaches may make the project eligible for credit under a government green building program or rating system such as LEED.⁴

- **Marine grade stainless steel mesh screens** with apertures smaller than 0.02 inches can be installed under the foundation, at the base of wall systems, under sill plates, around expansion joints and pipes, at perimeter wall junctions, on crawl space vents—anywhere there may be openings that allow termites to pass from soil to structure. For example, mesh can be fixed to service pipes that will extend through the concrete slab before the slab is poured, preventing even the tiniest gap. Mesh can be embedded into concrete, fixed to the concrete slab, or fixed to pipes.⁵



Termite screen

Photo: Polyguard

- **Particle barriers**, usually made from sand or rock, are effective when the particles are too close together for termites to pass through, and too large for them to move out of the way. Since native subterranean and Formosan termites are different sizes, the particles must be tailored to the species found where the barrier is being used—and a single size won’t be effective where both species are present. Although not common, particle barriers can be used on the exposed perimeter of buildings where the soil meets vertical concrete, in openings for bathtub plumbing (a favorite entry point for Formosans), and around other plumbing penetrations.⁶



Peel-and-stick flashing moisture/termite barrier (left); Photos: Polyguard
undersill moisture/termite barrier (above)



- **Geotextile membranes** come in a variety of configurations to protect various parts of a structure. Under-slab sheets include 8.5 mils of high-strength cross-laminated polyethylene backing topped with a 69-mil-thick layer of barrier sealant integrated into a high strength non-woven geotextile fabric. Peel-and-stick barriers, which come in large sheets or a variety of roll widths, consist of a 4-mil-high density polyethylene film bonded to 36 mils of sealant.⁷

When termite-resistant materials are used, an air barrier can also serve as a termite barrier. However, continuity is essential. Small deficiencies that don't pose much risk in terms of air tightness may still pose a risk for termites.

As with all of the tactics described in this paper, execution is key to effectiveness. A barrier that is poorly installed, damaged, buried by improper grading, or otherwise changed may not be effective. Similarly, if part of a barrier is removed and not replaced—to fix plumbing, for example—it ceases to prevent termites.



Continuous air barrier Photo: RDH Building Science

In-Structure Barrier

In new construction, a borate treatment may be applied once the building has been closed in, before drywall installation. While offering additional protection, borates should be limited to use in applications not in contact with the ground and continuously protected from liquid water. Surface treatments are not a replacement for pressure-preservative treatment, which forces the preservatives deep into the wood.

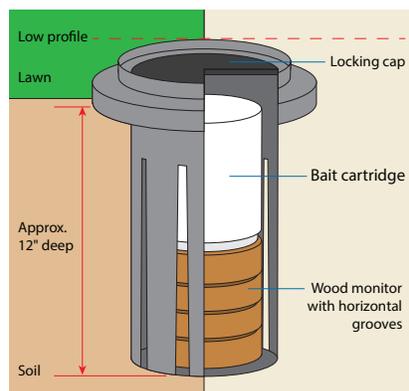
Bait Systems

Bait systems are comprised of stations inserted into the soil around a building—approximately 2-4 feet from the foundation at no more than 20-foot intervals. Stations are filled with a treated, cellulose-based food source.

Bait systems typically use toxicants that are slow-acting and undetectable to termites. Over a period of several months, termites that ingest the toxicant contaminate other termites through contact and food sharing, reducing or potentially destroying the colony.

Baits offer a long-term approach to termite control. Although they may require a month or more to be effective, they work well once termites find them.

As with all termite prevention options, bait systems are a matter of preference. They offer a low-impact approach, requiring less chemical, and an alternative solution where the building is close to a well or cistern, the site has a high water table, or soil termiticide treatments are likely to wash away or be disturbed (e.g., by storms, landscaping practices, pets, or wildlife). However, success depends on proper installation, monitoring and maintenance.



Termite bait systems require ongoing contracts with a pest management professional. If baits are chosen as the only method of treatment, there is nothing protecting the structure should the building owner discontinue the maintenance contract.

Slab and Foundation Details

Whether the slab is monolithic or floating, proper detailing can increase termite resistance by preventing access and simplifying inspection. Alternatively, poorly designed slabs weaken the entire pest control strategy.

“Termites can exploit any gap, including anchors used to secure the sill plate to the foundation or slab,” says the University of Florida’s Dr. Oi. “In multi-family and commercial construction, slabs that contain cold joints or have post-tension cable construction should be given extra attention.”

Best practices, which reiterate some of the tactics noted above, include the following:

- Detail the slab to avoid shrinkage cracks greater than 0.03 inches (1 mm) wide—e.g., with appropriate concrete mixtures or monolithic pours.
- Protect the slab with appropriate chemical and/or physical barriers.
- Minimize slab penetrations such as expansion joints (e.g., with separately poured bay windows).
- Protect slab penetrations with a termite barrier such as steel mesh.
- Position cladding at least 6 inches above the soil to ease inspection, bearing in mind that landscaping may increase the height of the soil.
- End insulation or drainage batts 6 inches below the cladding.
- For easy inspection, design crawl spaces at least 24 inches high with access hatches. Position hatches inside the building to avoid gaps or openings in exterior walls.
- Keep all plumbing and electrical conduits off the ground in crawl spaces. Do not support them on wood blocks and treat any alternate materials. (Soil termiticides are commonly used.)
- Consider incorporating termite barriers into suspended floors.
- For smaller commercial buildings, consider a suspended or supported slab (extends completely across the foundation) or a floating slab.

It is a common best practice to install metal termite shields (flashing) to the top of foundations/piers and sill plates. Although not an effective control strategy on their own, the idea is that termites will be forced to go around the shields, making it easier to spot their mud tubes during inspection.

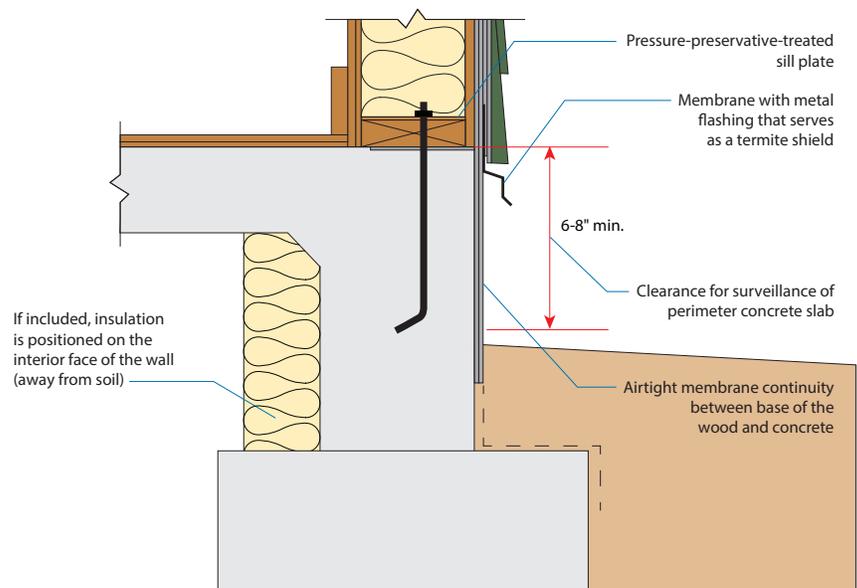




Photo: Brett Drury

Podium Construction: Another Level of Termite Protection

Podium construction, which typically includes multiple stories of light wood framing over a single or multi-story concrete podium, can increase termite protection if the poured concrete level is left exposed. While codes require 6 or 8 inches of clearance, a single-story podium offers 10-15 feet of clearance between the wood framing and ground. This helps to prevent termite access, eliminates the issue of having soil or landscaping encroach on the clearance over time, and simplifies inspection. In areas prone to flooding, it also helps to ensure that the wood-frame stories dry quickly after a storm.

Note: If the podium level is covered with brick or other cladding, minimum clearance would be needed to allow proper inspection, just like a non-podium structure.

For some building owners, podiums may offer the peace of mind required to choose wood-frame construction—allowing them to benefit from its economy, design flexibility, construction speed, and light carbon footprint.

Insulation Best Practices

As with many aspects of building design, considering insulation from a termite-prevention perspective and taking the right precautions can make the risk negligible. This is true of both wood and non-wood construction. Foam board insulation creates an ideal termite habitat when positioned below grade on the exterior of a structure. (The IRC prohibits it below grade for that reason.) Spray foam insulation in crawl spaces is also risky because it hides termite activity. In multi-unit buildings with a crawlspace or basement foundation, avoid spraying foam over the wood substructure resting on the foundation (i.e., sill plate, rim joist, and joist ends) to allow for early termite detection. Maintaining clearance between the insulation and ground is one of the best protection measures, and some companies offer termite-resistant insulation products. Subterranean termites are not generally found in fiberglass or treated cellulose insulation.

Surveillance and Remediation

Inspection for pests should be part of a building's regular maintenance strategy. A professional inspection should be done annually, both to check for the presence of termites in or around the structure, and eliminate potential access points. Areas to watch for include:

- Cracks in slabs or other types of foundations
- Roof or plumbing leaks
- Roof gutters that aren't directing moisture away from the building
- Other areas where moisture may be accumulating—e.g., around dishwashers, dryers or air conditioners, poorly ventilated bathrooms, standing water on roof, hose bibs
- Untreated wood in contact with soil that could offer access to the building—e.g., firewood, cardboard or other cellulose materials in crawl spaces
- Soil, mulch or roots that may compromise the required clearance or effectiveness of the physical barrier

If subterranean termites are detected, the pest control company should be able to determine the species and extent of the issue, and recommend remedial action. In addition to repairs (e.g., to eliminate moisture issues), this may include chemical treatment or a bait system.

Costs and Warranties

The cost of termite treatment varies based on region (and degree of risk), size of the structure, and other variables.

For example, Steve Ogier, President of ContraVest Builders, uses chemical treatment for all of his multi-family projects. Before the slab is poured, the pad area is treated and covered with a vapor barrier. Pipes that penetrate the slab are taped and sealed, and the perimeter of the building is treated again post-construction. For a recent 112,000-square-foot apartment building, the cost of the treatment was 6 cents per square foot, or \$6,720—a negligible expense for a project budgeted at \$35 million. The treatment comes with a five-year warranty, and the building includes both flashing and 6" of exposed slab below the exterior cladding to facilitate inspection.

As an example of physical barrier costs, John Muncaster, CEO of Polyguard, says his company offers flashing moisture/termite barrier (12" width) for \$2.40/linear foot (lf), undersill moisture/termite barrier (8.5" width) for \$2.85/lf, and sealant for slab penetrations for between \$1.50 and \$3.00 each depending on size.

There are two types of termite contracts or warranties—those that include retreatment only and those that include retreatment and the repair of damage caused by termites if found during the contract's term. For GCs, the best advice is to shop around for a firm you can use for all of your projects in the region. Take the time to find a reputable company that aligns with your preferences and is cost competitive, and preventing termites can require minimal effort from you over

the long term. Be cautious about contracts that only cover native termites; effective protection will cover all species potentially found in the region.

Understanding the Threat: Other Wood Boring Pests

Although this paper focuses on subterranean termites, other wood-destroying pests can damage buildings and may require different control techniques.

- As their name implies, **drywood termites** affect dry wood such as attic framing. Treatment options include fumigation, spot treatment (e.g., pesticide foams injected into galleries within the wood), heat or microwave treatment, and the replacement of infested wood. Tent fumigation is used in certain states to address extreme infestation, but is cumbersome and labor intensive. In the U.S., drywoods are primarily found in southern coastal areas and Hawaii. Some species found in furniture are considered to have worldwide distribution.
- **Dampwood termites** thrive in wet environments such as decaying stump and logs. They're most common in the Pacific Northwest, but aren't a concern for buildings as the wood needs to be very wet. Treatment includes eliminating sources of moisture, as well as the options listed above for drywoods.
- **Carpenter ants** don't feed on wood; they excavate galleries to create nests within wood, and deposit the debris in small piles. In buildings, they tend to be associated with moisture problems (such as unsealed openings around utility pipes) as they prefer wood softened by mold and decay. Treatment options include removing or treating the nest, and eliminating source(s) of moisture. In the U.S., carpenter ants are found primarily in the Northeast.
- Adult **powder post beetles** don't eat wood, but their larvae consume the soft sapwood layer of species such as maple, ash, oak, and pine. In most cases, powder post beetles are introduced to a building through infested lumber, especially old, untreated wood from barns or other outdoor sources, or products such as furniture and paneling. Borate treatment can be highly effective in preventing infestation, and infestations can be treated after the fact with fumigation. Powder post beetles can be found along the eastern and western U.S. coastlines.

With all of these pests, it is wise to contract a pest management professional to treat indoor infestations. If a threat is detected, it may also be useful to contact the nearest National Pesticide Information Center county extension office. Each county in the United States has an extension office, which is staffed with agents who work closely with university-based extension specialists to answer questions about pest control, agriculture, and gardening. You can find the phone number for your local county extension office at www.npic.orst.edu/pest/countyext.htm.

Routine Inspection = Early and Accurate Treatment

While some homeowners take pest control into their own hands, owners of multi-family and commercial buildings tend to think of it as routine maintenance and use the services of a pest management professional. The cost isn't onerous, and regular inspections mean that potential issues can be spotted and addressed early. For example, termites, carpenter bees, and powder post beetles can all cause damage to buildings, but they require different treatment strategies. Identifying them correctly is key to getting rid of them quickly.



Clearance between landscaping and the structure allows for easy inspection

Photo: Charlan Brock Architects

Conclusion

With proper design and detailing, good construction practices, and ongoing maintenance, wood-frame buildings can be as termite-resistant and durable as buildings made from other materials, which often require the same approaches to subterranean termite prevention. Effective pest management doesn't have to be onerous or cost prohibitive; it just needs to be well thought out and properly executed by a pest management professional.

If you have additional questions, WoodWorks provides free project assistance related to the design, engineering and construction of commercial and multi-family wood buildings. A non-profit organization staffed with architects, engineers and construction specialists, we're available to assist on a wide range of topics. Visit www.woodworks.org/project-assistance to contact the expert in your area, or email help@woodworks.org.

WoodWorks also offers education across the country, and offers an extensive library of technical papers, design examples, case studies, and design tools related to wood-frame and mass timber construction—all free of charge. For more information, visit www.woodworks.org.

End Notes:

- 1 Morris, P.I., *Integrated Control of Subterranean Termites: The 6S Approach*, 2000 Proceedings of the American Wood Preservers' Association, Forintek Canada Corporation (FPInnovations), 2000
- 2 https://preservedwood.org/portals/0/documents/PT_fasteners.pdf
- 3 https://preservedwood.org/portals/0/documents/PS_UC_Residential.pdf
- 4 <https://www.usgbc.org/credits/homes-high-rise/v4-draft/ssc3>
- 5 www.termistopusa.com; www.polyguard.com/term/termite-barrier
- 6 www.hcdhawaii.com/product-basaltic-termite-barrier
- 7 www.polyguardproducts.com/term/

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