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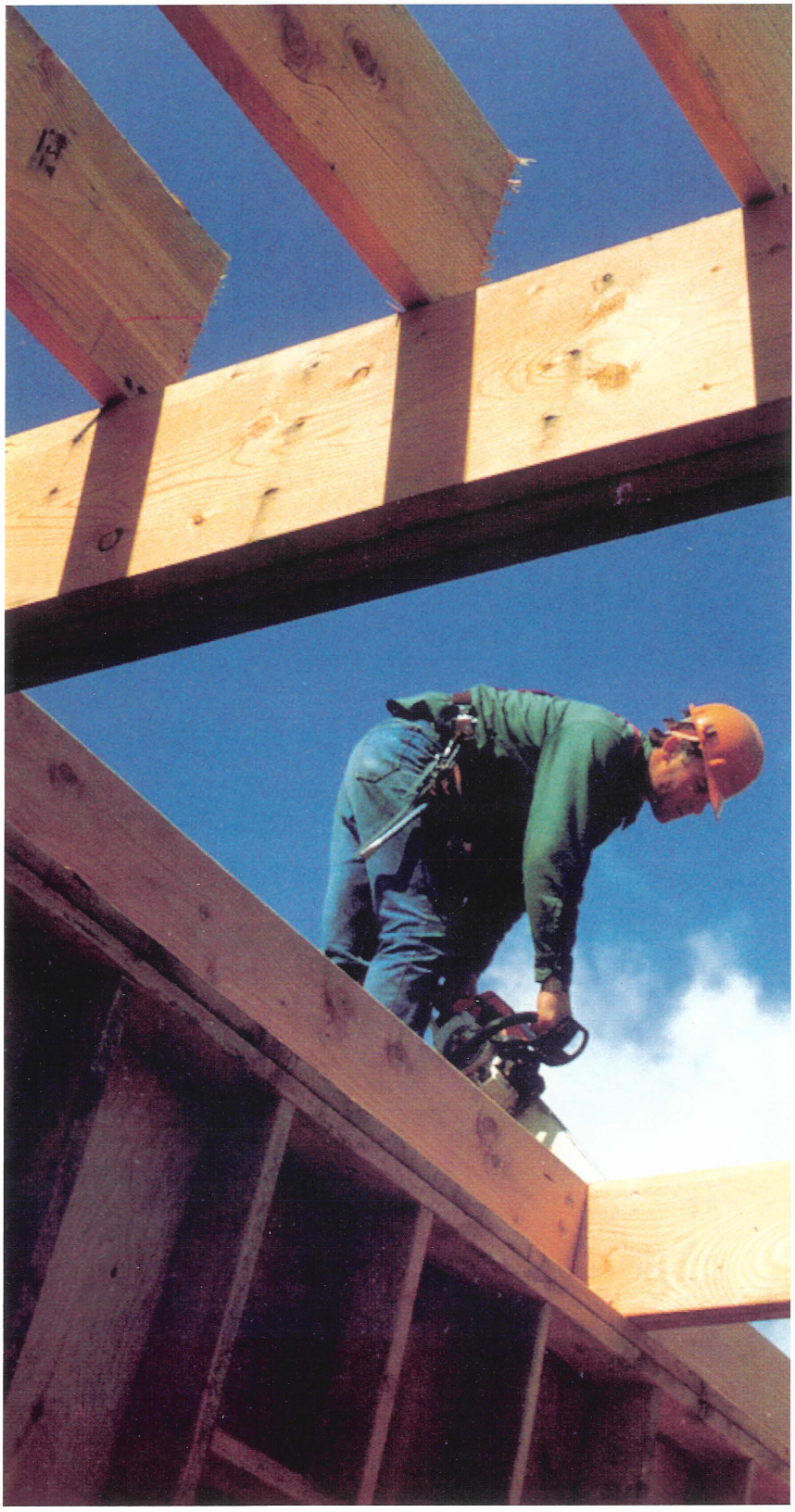
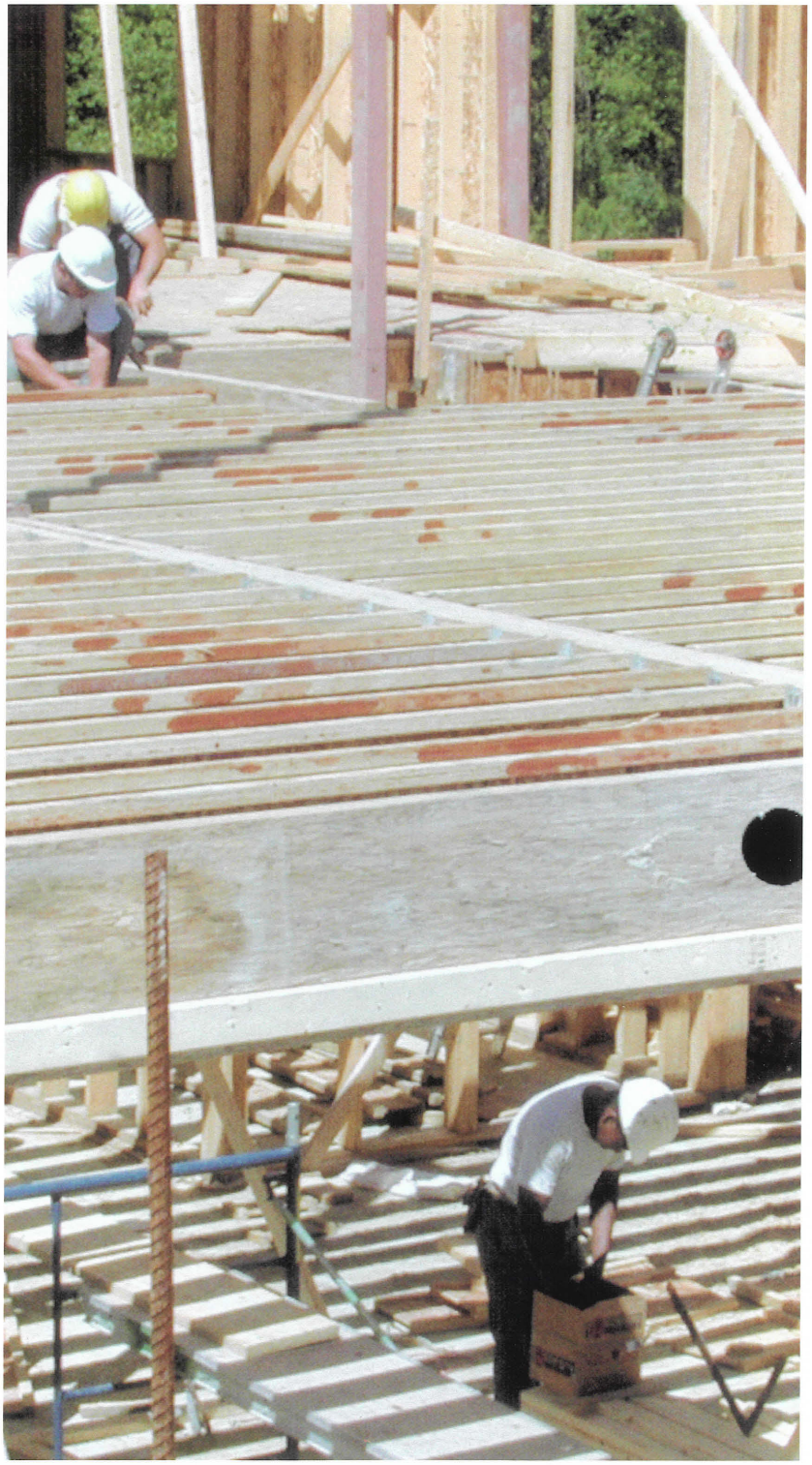


Termite Control

and Wood-Frame Buildings

INTERNATIONAL

Building series | NO. 7



Introduction

Wood products have long been the building materials of choice for home construction throughout many parts of the world. The wood-frame construction system has a solid history of producing housing of the highest standards: It is easy to build, delivers economic value, has excellent strength in earthquake or high-wind conditions, is energy efficient, and is derived from a renewable resource.

Modern wood-frame construction includes several types of engineered wood products that are economically viable in multi-story residential buildings and non-residential projects. Moreover, as described in Bulletins No. 1 and 3 in the International Building Series, wood framing supplies durability and fire safety performance where environmental and building code requirements are met.

This bulletin describes how wood framing can also be used in areas of the world subject to insect attack, a threat to all types of buildings. It builds on the concept of integrated pest management that will provide long-term protection for wood-frame and other buildings against damage caused by insects, specifically Formosan and other subterranean termites.

Also included is practical advice for building designers, contractors and owners to assist in assessing risk, and choosing appropriate mitigation measures.

Integrated pest management (IPM) is a strategy that combines different pest control measures (see Integrated Pest Management section) and applies these at varying frequencies and degrees depending on the stage of an actual or potential infestation. As conditions change, control measures can be applied to meet the increased or decreased insect hazard, while always maintaining an appropriate level of base protection.

Durability and Wood

Prevention of insect damage and decay caused by penetration of moisture are key issues when building with wood. Proper construction detailing to ensure long-term durability of wood-frame buildings in high moisture conditions has been described in Bulletin No.1, *Moisture and Wood-Frame Buildings*, of the Canada Wood International Building Series.

Insects – mainly termites, beetles and ants – can cause significant property damage. However, insect damage need not occur and the information in this bulletin is intended to help prevent this damage.

Insect damage is not restricted to wood-frame stuctures and one- or two-story developments. In fact, termite colonies, sustained by moisture from rainwater or other sources, have been found as high as the 17th story in some concrete buildings In the United States, Honlulu and Miami.

Nor is damage entirely restricted to wood or cellulose based components. Termites chew throught cable shields, plastic laminates and foam insulation. In areas where there is an identified risk of termite infestation, it is prudent to take precautionary measures, whatever the building size or construction type.

Certain types of insects such as the powder post beetles and carprenter ants cause limited damage and are relatively easy to control.

Subterranean termites, those that enter buildings from nests underground, are one of the most economically significant insect pests in terms of damage. For example, in the southern U.S. the Formosan subterranean termite (FST) or *Coptotermes Formosanus*, is responsible for a significant portion of all insect damage to buildings.

It is now generally recognised that total eradication of these insect pests is not a realistic goal, and that pest control efforts should be focused on containment of existing insect populations, and on the limitation of risk to buildings through the implementation of integrated pest management strategies.

One such approach, the "6-S" strategy, is described in this guide[1]. The 6-S strategy includes:

- Suppression
- Site Management
- Soil Barriers
- Slab and Foundation Details
- Structural Protection
- Surveillance and Remediation

The measures required in any individual situation will depend on the type and number of insects present in the area, and the threat that they represent to a given structure.

In areas where termites are well established, they pose a very significant threat to buildings, and therefore demand the most comprehensive response. Other insect perts can typically be controlled by selecting the most appropriate control measures from those listed below in Integrated Pest Management.

[1] Morris, P.I. 2000. Integrated control of subterranean termites: the Six S Approach. Proceedings of the American Wood Preserver's Association. 96: 93-106

Insects That Damage Wood

Termites

Worker termites can be distinguished from worker ants by their creamy-white color and slower movement. During the flying stages (alates) termites are distinguishable from ants by their thicker bodies, straight antennea, and by the equal size of their front and rear wings (see figure 1). There are many types of termites among those that cause the most structural damage there are: wood inhabiting termites and subterranean termites. Wood inhabiting termites can attack either dry wood (drywood termites) or dead or rotten wood (dampwood termites)

Dampwood termites primarily attack decaying wood (or sick or dead trees). Eliminating the moisture source leading to the decay normally controls them. They do not generally constitute a major risk to a building's integrity.

Drywood termites need no significant moisture source, and may consequently fly into buildings and set up colonies in dry wood, bypassing the physical barriers used against other termites. Drywood termites can be combatted by the use of treated wood components, and eradicated by fumigation or heat treatment.

FIGURE 1: Appearance of Termite vs. Ant
(Sources: Louisiana State University, Agricultural Center)

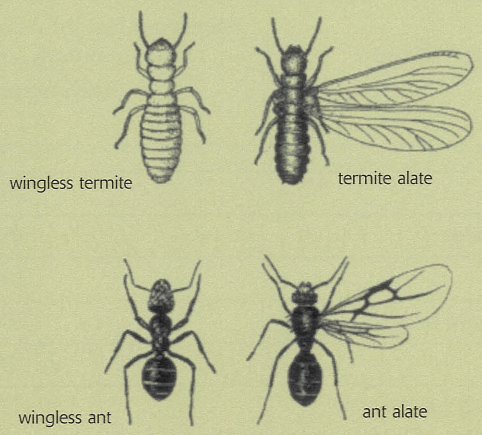


PHOTO 1: Subterranean termites build shelter tubes or mud tubes that serves as "climate controlled" access routes to a buiding. (Photo: Louisiana State University, Agricultural Center)

Subterranean termites are susceptible to desiccation, and require a reliable source of moisture, usually soil. Although satellite nests may be found in buildings if there is moisture, the main nest is usually found in wood that is in contact with soil. Subterranean termites build characteristic shelter tubes of mud, wood fibre and saliva, that allow them to pass from the soil into buildings, protected against desiccation and predators. These tubes may cross inert material, such as concrete foundations. Termites can also pass through cracks in concrete as narrow as 1 millimeter.

When a termite colony has grown to a sufficient size, winged alates develop and fly at particular times of the year to establish new colonies. They rarely travel more than 500 meters from their nest before descending, pairing and digging into the ground to establish a new colony.

Control Measures Integrated Pest Management (Termites)

As previously discussed, *integrated pest management* is a strategy that combines different pest control measures. Below is one approach to formalising an integrated pest management strategy using six lines of defense: The Six S approach. The number of control measures and the intensity of each measure are largely based on an assessment of the costs versus the risks.

Suppression

Suppression refers to measures intended to reduce and eventually eradicate termites from infested materials in a designated area. The area can be as large as a portion of a state, province or territory or may be limited to a single house.

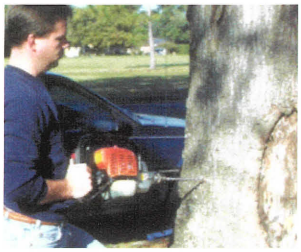


PHOTO 2: Trees containing termite nests can be injected with termiticide to reduce termite populations in designated areas. (Photo: Louisiana State University, Agricultural Center)

Attempts to reduce termite populations over a specific area, are useful where termites have been recently introduced, are sporadic in distribution, and primarily spread through man's activities.

If done on a regional basis, baiting (see Surveillance and Remediation) and trap-treat-release methods may also contitute an effective method of suppression. Area-wide suppression is obviously beyong the means of the builder or homeowner as it requires a concerted effort and coordination of various levels of government. However, in some areas baiting is commercially available to homeowners and can be an effective alternative to chemical soil treatment.

Suppression methods include systematic location and destruction of colonies not associated with buildings (such as in street trees), systematic inspection of wood products leaving an infested area to quarantine the infestation, burning of infest lumber and heat treatment of reclaimed lumber.

Site Management

Careful site preparation and clean-up can fo much to discourage the colonisation of a new or existing building site by termites. Where forest or orchard land has been cleared, tree roots must be completely excavated and removed along with any other buried wood.

During construction, it is important that:

- Stumps be removed,
- All wood and other cellulose containing construction debris be removed from the site,
- Survey pegs and concrete formwork be removed and disposed of properly, rather than buried or encased in concrete,
- Excavation spoil is not used to fill in under porches or steps,
- Site grading drains water away from the building, and
- Non-treated wood elements be raised from the ground according to the table below.

For landscape management of existing sites, it is important that:

- There be no wood-to-soil contact for untreated wood, including things like wood piles, sheds or patios – these should be raised from the ground onto patio stones or blocks, and
- All posts be mounted on metal brackets or concrete poste supports.

TABLE 1: Height above ground of non-treated wood elements.

Non-Treated Wood Element	Minimum Height Above Ground Permitted (millimeters)[1]
Floor joists	460
Studs	200
Wood veneer	150
Girders	300
Posts in crawl spaces	200
Columns	150
Columns above concrete	25

[1]Based on the U.S. model building codes and American Forest & Paper Association recommendations.

Soil or Chemical Barriers

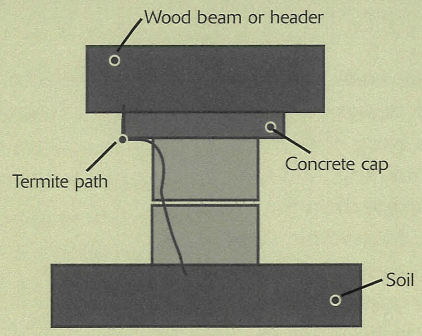
In the past, primary protection of buildings from termites infestation has been by the application of highly toxic and persistent chemicals, generally chlorinated organic compounds. When applied properly, and not breached or bridged, such barriers could exclude termites for up to 50 years. In some areas, these chemical have been replaced by less persistent chemicals such as pyrethroids, which have shorter effective lives, typically about 5 years. These chemicals should not be used on sites with wells or other ground sources of water supply. Also, there may be difficulty in reapplying the treatment, particularly if the building has a slab on grade.

Recently, a new generation of physical barriers promises longer effective life without negative environmental impacts. These barriers consist of either a 100 millimeters thick layer of precisely sized sand or crushed stone beneath slab foundations, or inside the footer and along the outside of the stem wall of crawl-space foundations. The sand particles are too heavy for the termites to move, and the spacing between them too small for the termites to squeeze through. The most effective particle size has been found to be between 1.5 millimeters and 2.5 millimeters in diameter, but varies according to the termites species in question. In Hawaii, where they were first developed, sand barriers are referred to as basaltic termite barriers (BTBs).

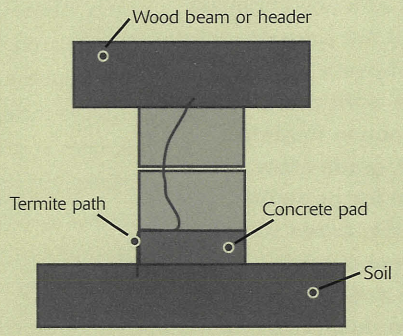
The installation and maintenance of sand barriers requires attention to detail:

- The material must be properly tamped, and left undisturbed by anyone working around the foundations,
- Detailing must ensure that water drains away from the foundations,
- Mulch, topsoil, etc. must be kept away from the building and not allowed to bridge across or bypass soil barriers, and
- Trees should be planted far enough away so that branches and roots do not reach the building.

FIGURE 2: Caps and Pads – A Building Tip for Pier Construction



Brick and hollow block piers can be made more termite resistant through the use of solid concrete caps. Caps force termites tunneling within the hollow blocks to move to the exterior of the cap where they can be detected.



Solid concrete pads also force termites to build exterior mud tubes for easy detection. Pads are easiest to treat since only the soil around the perimeter needs treatment, not the interior of the pier. The pad should have no cracks and extend above the soil.

Slab and Foundation Details

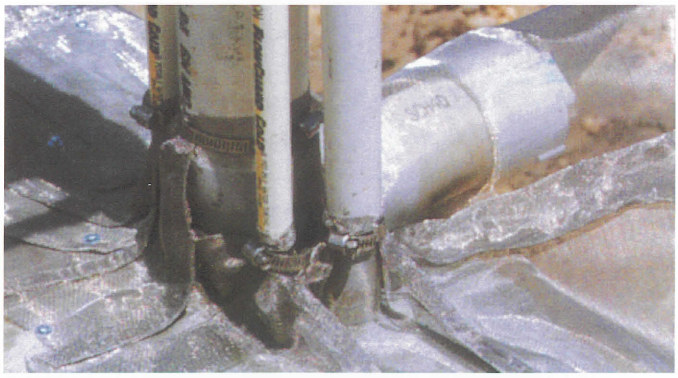


PHOTO 3: Termite mesh, a more recent development, is used to wrap the perimeter of the foundation or to prevent termites from gaining access through service penetrations. (photo: Termi-Mesh Florida LLC)

Foundation walls and slabs should be designed to inhibit the entry of termites into the building, and to facilitate inspection for shelter tubes. Monolithic slabs should be designed so that shrinkage cracks do not exceed 1 millimeters in width. Control joints in non-monolithic slabs should be similarly designed. Any openings cut for pipes and other penetrations should be sealed with non-shrinking grout, and the sides of foundation walls or slabs should be sufficiently exposed above finished landscape grade allow inspection for potential shelter tude. Crawl spaces should have enough clearance and have access hatches for inspectors to view potential termite entry points. If hollow masonry units are used for foundation walls, they must be capped with concrete and protected by an effective chemical soil barrier.

Sheet metal barriers can be installed between the top of the foundation and the sill plate, with the outer edge projecting from the exterior of the building at 45 degrees, like a conventional flashing. Soldering the joints creates a continuous barrier. To enter the building, termites must tube out and around the metal projection, making detection of their pre-sence considerably easier. Sheet metal barriers, if properly constructed and regularly inspected can be a highly effective means of excluding termites in strucutres with crawl-space or basement type construction. However, if a basement is finished, the barrier is obstructed from view and the termites may use basement framing to gain access to the structure.

A more recent development is termite mesh. Mesh is used to wrap the perimeter of the foundation to protect at-grade or below-grade penetrations of foundations and slabs. Mesh should have a grid spacing of 0.8 millimeters to exclude even the smallest termites. Clamps are used to secure mesh to all pipes and other penetrations of the slabs, and are parged onto the foundations with a cementitious compound.

Licensed contractors can install marine grade stainless steel mesh, with an estimated 20-year service life. The steel grade resists corrosion, but can add to costs, that vary considerably according to the complexity of the foundation design. During construction, it is vital that all sub-trades respect the integrity of the termite mesh throughout the construction process.

PHOTOS 4,5 and 6:
Termite shields, or sheet metal barriers, are installed between the top of the foundation and the sill plate. By projecting out and down at a 45 degree angle, the barriers force termites to tube around them for easier detection. (Photos: Tim Myles, University of Toronto)

Structural Protection – Preservative Treatment

For many years, preservative treated framing has been used in parts of buildings in termite areas. Buildings codes vary in requirements – some specify that timber elements 450 millimeters or less from the ground be treated, others may require that other specific elements be treated. Preservative treatments such as Alkaline Copper Quaternary, Copper Azole and Borate provide adequate protection against attack by termites.

Since 2000, several wood preservative producers jointly launched a range of wood products treated with borate (B_2O_3), a water-soluble chemical that kills insects that feed on it, while being considered benign in contact with humans. In its various forms borates already appear in a range of common domestic products from eye-drops to washing powder.

Products such as zinc borate treated structural panel sheathing, cellulose insulation, and sodium borate-treated dimension lumber are becoming widely available, making it more feasible to construct a house in which many primary and secondary structural components are termite resistant. It is believed that the water-soluble borate treatment can actually migrate towards the moisture generated by termites in the tubes, and in doing so, repel or kill the insects. Borate-treated wood is not recommended for use in the outdoors without a three-coat finish, e.g., for decks, due to water solubility. It is very suitable for use as framing lumber in structures.

As with cement dust and other building materials, treated wood requires some care in handling during construction. Builders and do-it yourself enthusiasts should refer to Consumer Information Sheets for the appropriate health and safety precautions in using preservative treated wood. Borate-treated wood should be transported and stored under cover prior to construction and should be closed in as soon as practicable. Short-term exposure to rain during construction is not a problem. Some wood species are naturally resistant to termites and can be used for interior finishes and fixtures. Where appropriate, these species can also be used for structural members offering an alternative to treated wood.

Surveillance and Remediation

Regular inspections are necessary in identifying any problems while they are still manageable, and the identification and eradication of termite colonies that are in proximity to buildings, is fundamental in reducing risk. As part of this surveillance, it may be appropriate to use specific remediation measures to prevent recurrence of the problem. In recent years, the general application of toxic chemicals to eradicate termites as a remediation measure has been replaced by more focused approaches, such as baiting, that are less hazardous to the environment.

PHOTO 7: Protecting the structure by building with borate-treated wood products is a suppression option in certain situations. (Photo: Louisianna-Pacific® SmartGUARD™)

Remediation 1: Baiting

Baiting involves placing bait tubes or traps in the ground at intervals around a building – several dozen for a typical house. Pieces of untreated timber or other cellulose-based material are inserted into these tubes as bait for termites. The tubes are monitored and, when termites are observed feeding on the bait, it is replaced with treated bait containing a chemical that the termites then carry back to the colony. The chemical is slow acting, so termites are unable to associate its source with its effects. Over a period of several months, the entire colony may be destroyed.

When no further activity is observed in the tubes, the treated bait is removed, and replaced with untreated bait. Monitoring continues on a regular basis, and the procedure is repeated as necessary.

Several companies offer products and services that are variations on this method of site treatment, although baiting is still a relatively new approach for termites.

PHOTO 8: A bait assembly being installed beneath a patio. Baits contain slow-acting termiticide that termites carry back to infest the entire colony. (Photo: Louisina State University, Agricultural Center)

Remediation 2: Fumigation or Heat Treatment

The chemical fumigation of heat treatment of a termite infested building requires the services of a licensed professional contractor. There are two basic approaches to remediation: fumigation, and heat treatment. The chemical compounds used in fumigation are toxic, and generally require evacuation of the buildings for a period of several days.

To eradicate termites and other wood-boring insects with heat, the core temperatue of all wood elements in the buildings must reach 50˚C for a continuous period of 30 minutes. Generally, this will require the ambient air temperature in the building to be raised to 70˚C, (the temperature of a sauna), for about one hour. To achieve this, it is necessary to wrap the building in insulating material, and to protect heat sensitive items such as electronic equipment. Because it is almost impossible to maintain the required temperatures in wood elements that are in directions contact with concrete foutions (because of their "heat sink" effect), this method is most effective against non-subterranean specie of termites, carpenter ants and powder post beetles.

It should be noted that while either fumigation or heat treatment will eradicate insects from a building, they will not prevent reinfestation. Regular inspection and maintenance will do much to reduce the risk of infestation. Look for debris and other food sources and for potential bridges into the building (see Site Management). Also check for sources of moisture such as:

- Leaking downspouts or gutters,
- Poorly ventilated bath rooms, clothes dryers, etc.,
- Air-conditioner condensa tion leaks,
- Leaking pipes, and
- Leaking seals around windows and doors.

Assessing Risk and Choosing Appropriate Lines of Defence

Some indication of the area to which termites might spread can be deduced from the experience. That certain countries had with specific species. For example, in Japan, Formosan termites have not crossed the 4˚C January average minimum isotherm.

Of the six lines of defense described above, not all will be necessary or appropriate in every situation. In areas of low termite risk, only two or three lines of defense should be adequate. In areas of high risk, all six lines of defense may be needed. Table 2 lists the lines of defense recommended for various levels of risk.

University based urban entomologists and local pest control professionals are the best source of information, although mapping programs are underway in some areas that will assit designers and builders to make their own assessments.

A key factor will be the likelihood of termites becoming established locally during the life of the building.

In summary, minimising damage caused by termites should be based on the following principles:

- Control methods should be consistent with current and predicted threats of infestation,
- Control methods should be economically and environmentally feasible to reduce and contain the current termite population, and
- The public, building owners, designers and the construction community should encourage and adopt methods to prevent infestation.

Conclusion

Effective control of termites requires several lines of defence which may be selected from the six measures outlined in this bulletin. Allowances must be made for the inevitable imperfections in construction and maintenance. However, with the products, technologies and approaches now available, wood frame buildings remain a viable option even in the most termite-prone areas.

Finally, it is important to remember that termite problems are not soley limited to wood construction.

TABLE 2: Termite Control Stategies for Various Degrees of Termite Risk

Line of Defence	Termite Risk High & Formosan	High	Medium	Low
Suppression	√			
Site management	√	√	√	√
Soil/chemical barriers	√	√	√	
Slab/foundation details	√	√	√	√
Structural protection	√	R[1]		
Surveillance & remediation	√	√	√	√

[1]Recommended

Checklist for Staying Termite-free

If you live in a termite-prone area, assess your hazard exposure and use the information here to develop a termite management strategy that includes some or all of the control measures presented. Termite management is an ongoing process that, with constant vigilance and maintenance, can save a lot of trouble, worry and money.

- Have a professional inspection done every year,
- Keep termite habitats away from the immediate area around the building,
- Clear or relocate buried wood such as tree stumps, firewood, scrap wood, card board boxes and plants,
- Be vigilant for foundation settling or shifting that could open new paths for termite access,
- Quickly fix any roof or plumbing leaks so that moisture does not enter the building envelope,
- Keep roof gutters in good repair and ensure they direct water away from the building,
- Maintain the integrity of physical barriers such as sand or mesh – do not lay soil or mulch over the bar rier, or let roots grow through it,
- Repair poorly ventilated bathrooms, leaking pipes, clothes dryers and air-conditioner condensation leaks that result in termite-attracting moisture accumulation, and
- Do not store wood, cardboard boxes or other cellulose-based material in crawl spaces.

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Forestry Innovation Investment Ltd.

Québec

A publication of the Canadian Wood Council. Funding support provided by the Council of Forests Industries, the Quebec Wood Export Bureau (Q-WEB) and the Société d'habitation du Québec.