INTEGRATED CONTROL OF SUBTERRANEAN TERMITES: THE 6s APPROACH

by

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ABSTRACT

This paper provides a formal structure to assist specifiers in deciding on appropriate termite control measures for different levels of risk. Six lines of defence are outlined: Suppression, Site management, Soil barrier, Slab and foundation detailing, Structural durability and Surveillance and remediation. The characteristics of each are discussed. The potential for each of the six to be less than 100% effective due to less than perfect design, construction and maintenance and the need for several lines of defence are emphasised. More lines of defence are recommended in zones with higher termite risk.

KEY WORDS

Termite, suppression, site management, soil barrier, slab/foundation, structural durability, surveillance and remediation.

INTRODUCTION

Termites are a serious impediment to the use of wood construction in many of Canada's export markets such as the Southern USA, Japan and Southeast Asia. It is therefore useful for Canadian wood products and construction industries to have some knowledge of termite control measures. Termite control measures appropriate to each region are specified in local and regional building codes, however there has been no attempt to put all the control measures into an overall framework. This paper provides a formal structure to assist specifiers in deciding on appropriate control measures for different levels of risk. This has been dubbed the 6S approach. A similar approach has proved successful in embedding the concept of multiple lines of defence into design for rain-penetration control (Hazleden and Morris 1999).

A brief review of termite biology, distribution and impact will provide context for discussion of control measures. Termites are social insects, related to cockroaches. They can be distinguished from ants by the absence of a narrow waist on the body. Under a hand lens, termite antennae are straight whereas those of ants have an elbow. Flying reproductive termites (alates) are distinguished from flying ants by the equal size of the four termite wings. Three types of termites are distinguished on the basis of moisture requirement:

- Damp-wood termites
- Dry-wood termites
- Subterranean termites

Damp-wood termites are prevalent in coastal British Columbia and the Pacific Northwest of the USA. They primarily attack decaying wood and are controlled by eliminating the moisture source that led to decay. They are not a major economic problem in buildings.

Dry-wood termites need no significant moisture source and mated pairs can fly into buildings and start a nest in dry wood. Consequently, control measures designed to separate wood from soil or moisture are ineffective. On the North American Continent, dry-wood termites are found only from the extreme south of the USA into Mexico.

Subterranean termites do need a reliable source of moisture, normally soil, but they have the capability to transmit moisture into buildings. Although satellite nests can occur in buildings, their main nests are normally in wood in contact with soil. Subterranean termites build characteristic shelter-tubes of mud, wood fragments and bodily secretions, which allow them to pass from soil to wood above ground without exposure to drying air or predators. These shelter tubes can extend for several metres over inert substrates, such as concrete foundations. Termites can also pass through cracks in concrete as narrow as 1.5mm.

Subterranean termites are the most economically important worldwide and for the rest of this paper termites can be taken to mean subterranean termites unless otherwise specified.

Within the subterranean group, further subdivision is warranted because of the extremely aggressive nature of one particular species: the Formosan subterranean termite – *Coptotermes formosanus* Shiraki. Although, individually smaller than species mentioned below, because of sheer numbers, Formosan colonies can be nine times more aggressive in terms of wood consumption. This species is particularly problematic in parts of the Southern USA, where it was introduced after WWII (Figure 1).

Fortunately for Canada, most of our country lies north of the limit for termites on the North American continent (Figure 1). However, because termites and people both prefer the warmer parts of the country, 20% of Canada's population live in areas where termites are present (Myles 1991). Long winters limit termite activity in the wild, but the warmth provided by our buildings seems to encourage more serious problems in urban environments (Grace 1990). Damage caused by the Eastern subterranean termite, (*Reticulitermes flavipes* Kollar), has reached economically important levels in areas of Toronto and other cities in Southern Ontario. There are some suggestions that the Western subterranean termite, (*Reticulitermes hesperus* Banks), may be causing significant damage in the Okanagan region of British Columbia. More important for Canada is the fact that much of our lumber exports are destined for regions where termites are a threat to wood frame construction.

The need to provide advice to companies exporting lumber, platform-frame technology or manufactured homes prompted a survey of termite control methods and the formulation of an approach to thinking about termite control through the design, construction and maintenance process.

Integrated Pest Management (IPM) is a concept developed in agriculture, transferred to termite control, but defined in different ways by different parties (Su and Sheffrahn 1998). In some cases it has been taken to mean simply reduction in use of pesticide, but in the strict sense it must comprise a combination of complementary tactics (chemical and non chemical) to manage pest populations. In agriculture, this involves monitoring pest populations and applying pesticides only when needed. Robinson (1996) notes that the original concept is not easily transferred to the urban environment. In the case of termites, the level of damage that occurs before the pest is detected may well be unacceptable to the homeowner. Robinson (1996) proposes that Integrated Pest Control (IPC) is a more accurate term for programs that would achieve an acceptable outcome. "The challenge for urban IPC programs in the household environment is not reduced pesticide use but the efficient (effective and economical) use of insecticides to provide a pest-free living space" (Robinson 1996). The approach outlined here is intended to show how wood preservation fits into integrated pest control.

THE 6S APPROACH

Termite control measures can be grouped into lines of defence (Table 1). These are:

- Suppression
- Site management
- Soil barrier
- Slab/foundation details
- Structural durability
- Surveillance and remediation

Summaries of the options within these lines of defence are provided in Table 2 for new construction and Table 3 for existing construction.

Suppression

Attempts to reduce termite populations over a wide area (State or Province) are probably appropriate only where termites are recently introduced, sporadic in distribution and primarily spread through man's activities. Examples would include Eastern subterranean termites in Southern Ontario and Formosan subterranean termites in Southern USA. Termites were first reported in Southeastern Ontario in 1929 and in Toronto in 1935, apparently introduced by ship from the USA (Grace 1990). Winged alates are rarely encountered in this region (Grace 1990) thus later distribution to other towns must have occurred through transport of infested material. Formosan subterranean termites were introduced to the USA by the military on wooden packing materials returning from Southeast Asia via Hawaii after World War II. They have become established in a number of port cities on the Gulf and Atlantic coasts and a few inland cities (Figure1). Formosan alates only fly about ¼ mile when they swarm (Yates and Tamashiro 1999) so natural spread is fairly slow.

Suppression measures may include burning infested lumber, heat treating reclaimed lumber, systematic location and destruction of nests not associated with buildings, such as in street trees, and inspection of wood products leaving the area (Tables 2 and 3). If done on a State- or Province-wide basis, baiting (see under Surveillance and Remediation) might also be considered as a suppression measure. If practiced intensively and continuously, these measures may reduce termite populations and slow the spread of termites to new areas.

Site Management

Careful site preparation before construction and subsequent clean up go a long way to delaying termite attack on a building (Tables 2 and 3). Particular care is necessary when new subdivisions replace forest or orchards. Stumps may contain termite nests and tree roots form a network of pathways for termites to follow. The site should always be inspected for nests and these should be removed and destroyed. Stumps, roots and other buried untreated wood should be removed. During construction, care must be taken not to leave untreated wood buried in soil or enclosed in concrete (e.g. leveling pegs). All concrete form-work should be removed and all wood offcuts and other cellulosic debris must be cleared from the site. No untreated wood or cellulosic materials, such as cardboard, should be stored in crawlspaces.

Soil Barrier

The main line of defence against termites is normally a barrier to keep termites away from the building (Table 2 and 3). In the past, this was achieved using highly effective and persistent organo-chlorine insecticides such as Lindane, Dieldrin and Aldrin. When applied properly, and not breached or bridged, such barriers could exclude termites for up to 30 years. These products have now been replaced by less-persistent organo-phosphates and pyrethroids with effective lives between three and 13 years (Kard and Mauldin 1994). Perimeter foundation drains may make it impossible to apply a liquid soil treatment and such treatments should not be used where there is a well or cistern under the house. Reapplication of soil treatment can be difficult and disruptive, requiring drilling through slabs. This is impossible if the slab contains a hot water heating system. Installation of a reticulation (perforated pipe) system initially avoids this problem, but these can get blocked and the quality of re-treatment is unknown.

Two types of physical barriers have shown a great deal of promise as alternatives to soil treatment. These are graded gravel and stainless steel mesh. The graded gravel products work on the principle that certain sizes are too small for a termite to pass between them and too large to be picked up in a termite's jaws and used to build tunnels. The size of gravel or sand, therefore has to be different for different termites species. Care must be taken to control drainage through such systems to avoid diverting water towards the foundation. Over time, such graded gravel might be expected to silt up and methods for cleaning and renewal will be required.

Stainless steel mesh works in a similar way, in that holes in the mesh are too small for a termite to pass through and steel is too strong for termites to bite through. The mesh must be laid under the entire foundation and must be exposed above the soil surface all around the house. Due to the cost of this product, it is mainly used to protect penetrations in concrete slabs (see below).

With all the above soil-barrier systems, care must be taken not to breach them or bridge over them during subsequent landscaping or construction. A bridge can be as inconspicuous as a broom handle leaning on the wall or as obvious as attaching a new fence, deck, steps, porch or planter to the house. Such structures should be made of pressure treated wood and constructed so as to prevent access by termites to the house unobserved. Many experts recommend eliminating wood-earth contact, but this should be revised to read untreated wood-earth contact. Outbuildings, separate garages etc should not be attached to the house, even by an archway, unless they have the same protective measures as the house. Branches of trees, shrubs and climbers can bridge the soil barrier and should not be allowed to touch the house. A breach in the barrier can be created during garden work or via growth of tree roots through the barrier. Fresh soil or mulch should not be laid over the soil barrier. Given all these constraints, it is no wonder that, even with re-application, it is difficult to keep soil barriers 100% effective for the full life of the structure.

Bait systems are also proposed as a type of soil barrier but their long-term efficacy in this application has yet to be proven. They also require a long-term commitment to a contract with a professional company. For more detail on bait systems, see the section on Surveillance and remediation.

Termiticide-impregnated membranes have also been used as a barrier, but these also do not have a long track record. They might be expected to have similar characteristics to termite shields in that they require very careful installation, and termites may be able to get around them (see section on Slab/Foundation Construction).

Slab/Foundation Construction Details

Design and construction of foundations should minimise the possibility that termites can gain access to wood unobserved (Tables 2 and 3). While some details are designed to eliminate a particular access point, others are intended to allow inspection for shelter tubes over or around the detail. All these details still require ongoing surveillance.

If the foundation is intended to be a monolithic slab, it must be carefully designed and constructed so as not to develop shrinkage cracks over 1mm in width. Slab penetration for services should be minimised and all penetrations must be protected with a good-adhering non-contracting grout or one of the soil-barrier options. Non-monolithic slabs must also have all control joints and footing/slab joints protected.

All exterior slab edges or foundation walls must be kept free of cladding for a height of 150mm from the finished soil level to allow inspection for shelter tubes. Exterior insulation or drainage batts, must be terminated 150mm below the cladding. The height of the cladding must allow for any landscaping to be done right after construction or likely in future. Remember: ground levels always rise. That is why we have archeological digs.

Crawlspaces must be built so that they are easily accessible by inspectors. This means access hatches and at least 450mm unobstructed height. Suspended floors may incorporate termite shields. Similar to flashing, these are sheets of metal mortared into foundation walls or columns and sloped down at 45^{o}. Termites can construct shelter tubes around termite shields and these products are less and less frequently used.

If hollow concrete masonry units (CMUs) or double walls are used in foundations, they must be capped with concrete or masonry or protected using an effective soil barrier system. CMUs are so good at encouraging termite attack that we use them in our accelerated termite tests.

A considerable amount of information on protection by design is provided by Australian Standard AS3660.1 (Standards Australia 1995).

Structural Durability

Preservative treatment of the structural framing will minimise the effect of termite damage on the health and safety of the occupants. It will not prevent termite damage to other wood or plant fibre materials used in construction or interior finishing. Termite access must therefore be controlled by other lines of defence.

Most wood components can be preservative treated during or after manufacture or can be made from naturally durable woods (Tables 2 and 3). Some woods are naturally resistant to termite attack, but the level of resistance varies by wood species and termite species. Old-growth redwood, bald cypress, western red cedar and yellow cypress (Alaska Yellow cedar) are considered non-preferred by many termite species. Grace and Yamamoto (1994) found yellow cypress was significantly less preferred than redwood, southern pine and Douglas fir. In more recent tests, yellow cypress was significantly less preferred than bald cypress or redwood (Morales-Ramos and Rojas 1999). However, given the choice of eat cedar or cypress and eventually die or don’t eat and starve to death, some termites will eat a little of these woods. Furthermore, these species are not available in sufficient volume to meet the lumber demand for wood frame construction in termite-prone areas.

The most widely used preservative, chromated copper arsenate (CCA), has a 60-year history of efficacy against termites. However adequate penetration is required to provide long term performance (Morris and Motani 1997). CCA-treated lumber meeting AWPA C2 is suitable for framing, for direct contact with concrete or other moist building materials and for exterior applications.

Borates have been successfully used for protection of framing and sheathing against Formosan subterranean termite for over six years in Hawaii. However, the retentions required are considerably higher than those listed in AWPA C 31 for lumber and C9 for plywood. Retentions in those standards are only suitable for protection against *Reticulitermes* species. Borate-treated lumber is suitable for framing, provided it is continuously protected from liquid water, such as rainfall or chronic plumbing leaks. It should also be separated from concrete less than 150mm from soil level by a waterproof membrane.

Neither CCA nor borate is termite repellent and neither is immune to cosmetic damage – surface nibbling (Morris and Motani 1997, Grace 1998, Tsunoda *et al*. 1998, Tsunoda *et al* 2000). It must be recognised that preservative treatment of one component will not stop termites from crossing over to feed on another component. In areas where Formosan subterranean termites are present, codes typically required treatment of all framing and sheathing (Hawaii) or at least all wood within 1 metre of the ground (Japan). Ammoniacal copper zinc arsenate (ACZA) shows some initial repellency, possibly due to residues of the ammonia solvent. Many of the newer preservatives have laboratory data and some have field test data, but few have a long track record in service against termites.

Oriented strand board (OSB) is also now available, treated with zinc borate (ZB) during the manufacturing process. A standard for ZB-treated OSB is still under development.

Many engineered wood products can not be treated with water-based preservatives after manufacture and these are commonly proprietary products. It is therefore likely that preservation during the manufacturing process will also be proprietary and such products may have to be approved through ICBO or equivalent. Engineered wood products can be treated with organic solvent formulation, but there is concern regarding volatile organic emissions when used inside buildings.

Subterranean termites bring moisture with them in the form of higher relative humidity within their shelter tubes. However, designing the structure to minimise moisture accumulation in wood systems will contribute to reducing the risk of termite attack. Moisture sources that must be considered include construction moisture, soil moisture, rainfall, occupational sources (breathing, washing, laundry, cooking etc.) and leaking plumbing.

Steel- and concrete-framed buildings are not immune from attack since termites will consume any cellulosic material, such as kitchen cabinets, storage boxes, carpet grippers, books and the paper surface of drywall. The moisture brought in by termites may cause steel to corrode. Formosan termite colonies have been found on the top floors of concrete high-rises in Hawaii and Miami, supported by the moisture from leaking water tanks.

Surveillance and Remediation.

Surveillance can be practiced at a variety of levels, but if it is to be relied upon as a line of defence it must be done by a professional (Tables 2 and 3). At its simplest, the homeowner can check for breaching and bridging of soil barriers, look for termite activity on wood in the garden and look for shelter tubes on the outside of the foundation or in the crawl space. The level of activity in any shelter tubes found can be judged by destroying part of the tube and checking for re-building. Shelter tubes may be difficult to spot with the untrained eye and the first sign of termite activity is often the emergence of winged alates or the collapse of a wood component under load. A professional inspection is recommended before purchasing any house (wood-, steel- or concrete-framed) in a high termite risk area.

Remediation first requires elimination of the termite infestation (Tables 2 and 3). Whole-house fumigation will kill any termites in the building, but will not prevent re-infestation. Elimination of the termite colony, through a trap-treat-release or baiting system, is a more lasting option. Both methods use very small amounts of biocide which are taken back to the colony and distributed via social feeding or grooming behaviors. Trap-treat-release is a more labour-intensive procedure, since the operative actively applies the pesticide to the termites. However, it has been found cost-effective as part of a comprehensive research and control program where termites have been introduced (Myles 1994) Baiting is also labour intensive, but can be very effective in reducing termite populations over the short term and even eliminating entire colonies (Su, and Sheffrahn 1998). Both methods must be conducted on a broad area rather than a single house. Nature abhors a vacuum and when one termite colony is eliminated, surrounding colonies will move in to claim the territory. Indeed, the speed of re-colonization suggests they may use the tunnels of the dead colony (Ken Grace – personal communication).

Remediation also requires re-examination of all six termite-control lines of defence. Examples include: enhanced local suppression, review of site management, new or replacement soil barrier, location and protection of cracks in the slab, re-exposure of slab edges, replacement of damaged components using treated wood, treatment of sound structural wood members with a diffusible preservative and a heightened level of subsequent surveillance.

MAKING ALLOWANCES FOR LESS THAN PERFECTION

While there may be several options within each line of defence, none can be considered as substituting for another. It always necessary to use more than one, because none of them are 100% reliable over the long-term. Assuming 100% reliability requires a degree of perfection in design construction and maintenance that is impossible to achieve in practice (Hazleden and Morris 1999). There will always be minor flaws in design, errors in construction and lack of attention to maintenance. These must all be accounted for in planning for termite control. Figure 2 illustrates change over time in termite risk and the capacity to mitigate termite attack of the three built-in lines of defence. In this example, termite risk drops as a result of suppression and site management then gradually rises over the life of the building with lack of attention to site management. A small drop in risk is provided by the inclusion of some site management in a major upgrade after 30 years. The cumulative capacity of soil barrier, slab/foundation detailing and structural durability is illustrated by the shaded areas. In the design and construction segments, the left side represents the intended degree of capacity and the right side represents the effective degree of capacity (Hazleden and Morris 1999). For example, the drop in capacity for structural durability in the design segment could be failure to specify use of field-cut preservative. The drop in the construction segment could be failure to use treated wood for all components. In this example, the soil barrier and slab/foundation detailing would have provided 100% of the capacity required at the end of the construction process, but these systems inevitably began to deteriorate. It was structural durability that kept the capacity adequate for the life of the building. The saw-tooth pattern in the surveillance and remediation segment comes from the gradual decrease in effectiveness of a chemical soil barrier and the abrupt increase when it is replenished every 5 years. Note that re-applications of soil treatment could not be done as effectively as during construction. A sharp increase in capacity at year 30 would be provided by major repair and upgrading of the slab/foundation details plus in-situ preservative treatment of previously untreated components.

DECIDING HOW MANY LINES OF DEFENCE TO USE

All six lines of defence are not required in all termite zones. Decisions on the level of effort to put into new construction should be based on the presence or absence of Formosan subterranean termites and the prevalence of the local *Reticulitermes* species. In determining risk zones for the Formosan termite, some useful information as to the potential northern limit for natural spread (excluding transport by man) may be gained by examining experience in Japan where the Formosan termite has been established for a considerable time. In Japan, the Northern limit for Formosan termites roughly coincides with the 4°C January average isotherm (Japan Wood Preservers Industry Association undated). The same isotherm might be looked at for North America. Some indications of Formosan termite distribution can be gained from Figure 1, but more accurate maps are under development. Some indications of termite control measures appropriate for various risks are given in Table 1, but local building authorities and termite experts should be consulted. In Hawaii, houses should be regarded as “ships floating on a sea of termites” (Elmer Botsai – personal communication) and all six lines of defence should be used. In coastal British Columbia, site management, and surveillance may well be adequate. Additional measures over those recommended will reduce the risk of damage for insurers and provide peace of mind to the owners.

CONCLUSIONS

Effective termite control requires several lines of defence selected from the 6Ss: Suppression, Site management, Slab/foundation details, Structural durability, Surveillance/remediation.

The number of lines of defence should be adjusted to match the termite risk.

Allowance must be made for imperfections in design, construction and maintenance.

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Table 1: Termite Control Strategies for Various Degrees of Termite Risk

Line of Defence	Termite Risk			
	High +Formosan	High	Medium	Low
Suppression	✓			
Site management	✓	✓	✓	✓
Soil barrier	✓	✓	✓	
Slab/foundation	✓	✓	✓	✓
Structural durability	✓	R[1]		
Surveillance + remediation	✓	✓	✓	✓

[1]Recommended

Table 2: Integrated Control of Subterranean Termites in New Construction

Control Measure		Implementation
1.	**Suppression**	
1.1	Infested lumber	Burn or heat treat all infested lumber
1.2	Infested trees	Treat all infested trees
1.3	Transport	Inspect logs, forest products and soil leaving
2.	**Site Management**	
2.1	Nest removal	Remove and destroy all nests
2.2	Stump removal	Remove all stumps
2.3	No wood buried	Remove waste wood
2.4	Remove form-work	Remove all form-work
2.5	Crawlspace sanitation	No storage of paper, cardboard or untreated wood.
3.	**Soil Barriers**	
3.1	Installation of soil barrier	
3.1a	Soil Treatment or	Repeat every 3 years
3.1b	Steel mesh or	As recommended by manufacturer
3.1c	Graded gravel or	As recommended by manufacturer
3.1d	Bait system with 10yr contract	As recommended by manufacturer
3.2	Prevent bridging of soil barriers a,b,c	
3.2.1	Attached buildings	Outbuildings, separate garages etc should not be attached to the house unless they have the same protection.
3.2.2	Attached landscaping structures	Fences, gazebos, decks, trellises, etc attached to the house must be made of pressure treated wood and constructed in such a way as to prevent access by termites to the house unobserved.
3.2.3	Plants	Branches of trees, shrubs and climbers should not be allowed to touch the house.
4.	**Slab and Foundation Detailing**	
4a	Slab	
4a.1	For inspection	Edges of slab exposed 150mm below cladding
4a.2	For exclusion	
4a.2a	or	"Crack free" slab plus grout or mesh around all penetrations plus perimeter soil barrier
4a.2b		Conventional slab plus soil barrier throughout
4b	Crawlspace	
4b.1	For inspection	
4b.1.1		Provide hatch plus 450mm of unobstructed height to allow access
4b.1.2a or		Concrete exposed 150mm below cladding
4 b.1.2b		Fit termite shields
4b.2	For inspection and exclusion	Cap CMUs with concrete, masonry or mesh
4c	Solid Piling	
4c.1	For inspection	Provide 450mm of unobstructed height to allow access
4c.2	For inspection	Fit termite shields

Control Measure		Implementation
4b	Brick/CMU Columns	
4b.1	For inspection	Provide 450mm of unobstructed height to allow access
4b.2	For inspection and exclusion	Cap CMUs with concrete, masonry or mesh
4b.3	For inspection	Fit termite shields
5.	**Structural Durability**	
5.1	For structures with wood, steel or concrete as primary framing material	Treat wood structural members to AWPA standard or approved equivalent or use approved termite resistant species
6.	**Surveillance and Remediation**	
6.1	Inspection	By professional inspector
6.2	If termites found	
6.2.1	Eliminate colonies	
6.2.1a	Fumigate or	As recommended by manufacturer
6.2.1b	Bait +monitor or	As recommended by manufacturer
6.2.1c	Trap/Treat/ Release	As recommended by manufacturer
6.2.2	Repair defence and	Identify and repair gaps
6.2.3	Repair wood structural elements +	Repair with wood treated to AWPA standard or approved equivalent or approved termite resistant species.
6.2.4	Remedial treat structural wood	Spray treat all previously untreated sound wood structural elements with approved preservative.

Table 3: Integrated Control of Subterranean Termites in Existing Construction

Control Measure		Implementation
1.	**Suppression**	
1.1	Infested lumber	Burn or heat treat all infested lumber
1.2	Infested trees	Treat all infested trees
1.3	Transport	Inspect logs, forest products and soil leaving
2.	**Site Management**	
2.1	Nest removal	Remove and destroy all nests
2.2	Stump removal	Remove all stumps
2.3	No wood buried	Remove buried wood
2.4	Remove form-work	Remove any accessible form-work
2.5	Clear crawlspace	Remove paper, cardboard or untreated wood from crawlspace
3.	**Soil Barriers**	
3.1	Installation of soil barrier	
3.1a	Soil Treatment or	Repeat every 3 years
3.1b	Steel mesh or	As recommended by manufacturer
3.1c	Graded gravel or	As recommended by manufacturer
3.1d	Bait system with 10yr contract	As recommended by manufacturer
3.2	Eliminate bridging of soil barriers a, b,c	
3.2.1	Attached buildings	Separate garages and outbuildings etc from the house unless they have the same protective measures.
3.2.2	Attached landscaping structures	Separate fences, gazebos, decks, trellises, etc from the house or replace with pressure treated wood and construct in such a way as to prevent access by termites to the house unobserved.
3.2.3	Plants	Clear branches of trees, shrubs and climbers from the house.
3.3.4	Soil	Clear untreated soil or mulch from around foundation
4.	**Slab and Foundation Detailing**	
4a	Slab	
4a.1	For inspection	Expose edges of slab 150mm below cladding
4b	Crawlspace	
4b.1	For inspection	
4b.1.1a or		Expose concrete 150mm below cladding
4 b.1.1b		Retrofit termite shields
4b.2	For inspection and exclusion	Inject CMUs with termiticide and reapply regularly
4c	Solid Piling	Retrofit termite shields
4b	Brick/CMU Columns	
4b.2	For inspection and exclusion	Inject CMUs with termiticide and reapply regularly
4b.3	For inspection	Retrofit termite shields

Control Measure	Implementation
5. Structural Durability	
5.1 For structures with wood, steel or concrete as primary framing material	Spray treat all previously untreated wood structural elements with approved preservative
6. Surveillance and Remediation	
6.1 Inspection	By professional inspector
6.2 If termites found	
6.2.1 Eliminate colonies	
6.2.1a Fumigate or	As recommended by manufacturer
6.2.1b Bait +monitor or	As recommended by manufacturer
6.2.1c Trap/Treat/ Release	As recommended by manufacturer
6.2.2 Repair defence and	Identify and repair gaps in defences
6.2.3 Repair structural wood and	Repair with wood treated to AWPA standard or approved equivalent or approved termite resistant species.
6.2.4 Remedial treat structural wood	Spray treat all previously untreated sound wood structural elements with approved preservative.

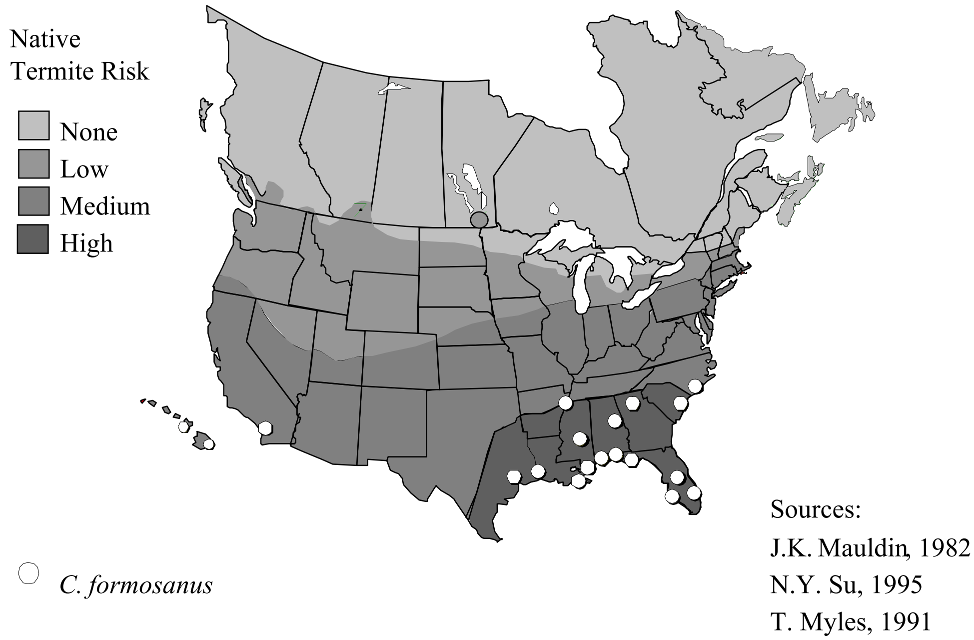

Figure 1: Subterranean Termite Risk Zones of North America

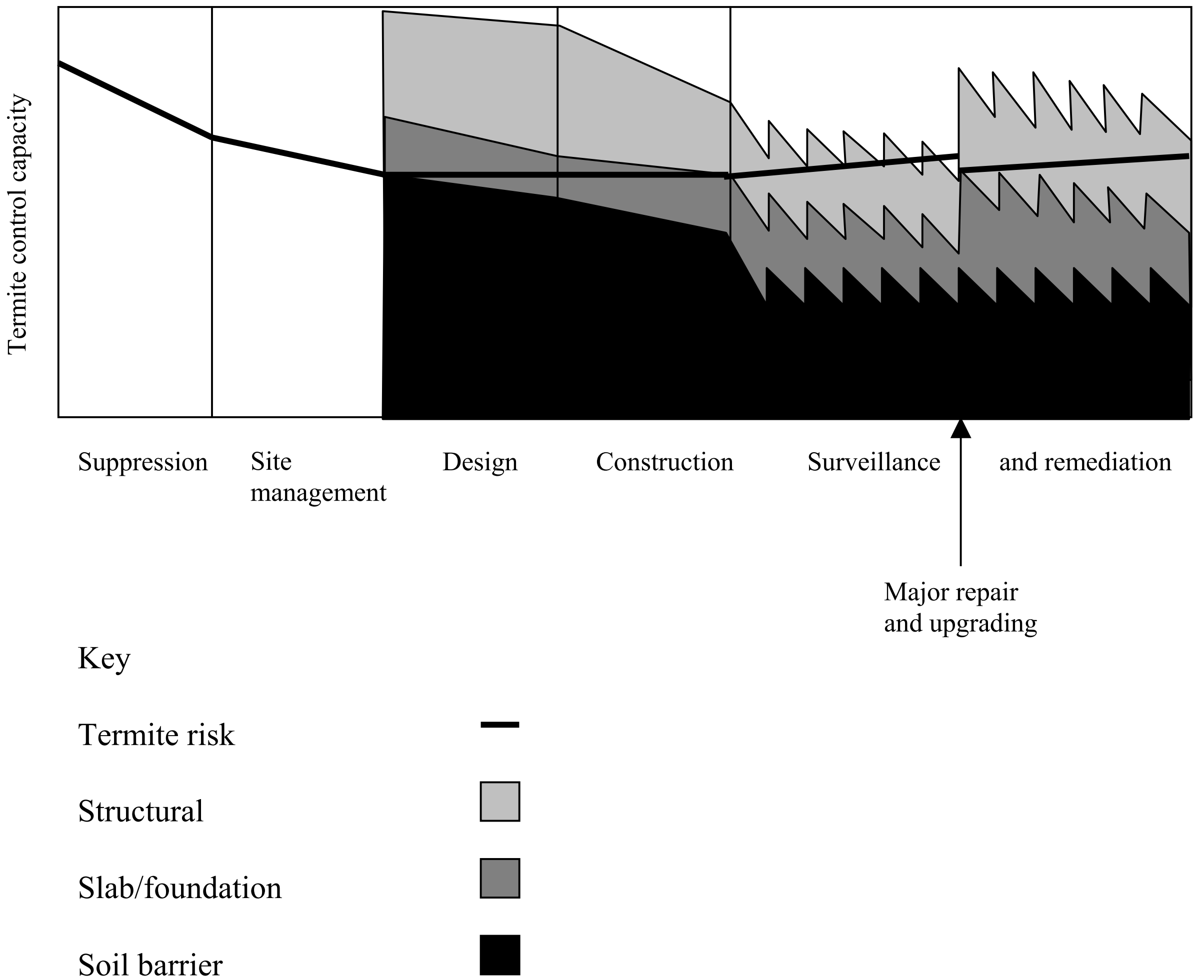

Figure 2: Change in Termite Risk and Termite Control Capacity over Time (not to scale)