Managing termite risk: core principles for construction

PURPOSE

This is a guide to help people manage termite risks in new constructions.

It is intended to help designers and builders of structures.

It is a general guide, written to explain the risks around the world, gives design guidance for risk reduction and the use of specific measures to limit termite attacks.

We are oping to get it down to 8, easier, to read pages.

This is pre-release version 0.85 a working draft saved 6 October 2021. Please check tiprm.com for the latest version.

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THE RISKS:

Termites may cause significant economic losses and may damage structures to the point that they become unsafe. The main risk happens when termites are present to eat woody things. Any material containing plant fibre is potentially at some risk. This includes timber frames, stumps, manufactured boards and consumer items such as furniture, clothing, art and packaging. Termites will also damage soft materials that get in their way such as plastic pipes and even synthetic carpets. Sometimes the damage is cosmetic or affects amenity but mostly our concerns are where damage is a risk to safety.

THE 8 PRINCIPLES FOR MANAGING TERMITE RISKS

1. Design and build with termites in mind
2. Design and build to suit local conditions, preferences and needs
3. Do the inexpensive things that reduce termite risks
4. Design for long-life and minimal service costs
5. Design for efficiency of materials, energy and any necessary pesticides
6. Don't use toxins when a non-toxic or least-toxic approach will do the job
7. Make it so that termite attacks are visible
8. Design and build so that maintenance is possible after termite attacks.

UNDERSTANDINGS

What are termites?

Termites are organised insects, a branch of the cockroaches. Individuals are small, but working in groups, they are smaller. Most termite species are not pests of structures. As pests they are long-lived, secretive animals which prefer to avoid the light and mostly stay inside their food. They can be very hard to find and may be active for a long time in a structure before any of their damage is noticed.

Structural risks

Termites mostly act where they are hidden from view and will consume the insides of load-bearing timbers leaving only enough to carry static loads. Structural damage can result in unexpected failure. This can happen during events like wind storms or earthquakes.

Damaged materials may include anything made from plant matter including cardboard, paper labels, cork flooring, bamboo and subterranean termites will sometimes damage clothes in storage, such as hanging in a wardrobe. Subterraneans will commonly damage plastic water pipes, insulation on wires, wall insulation materials such as expanded polystyrene and wall linings such as plaster board (dry wall).

Types of termites

By far the biggest threat comes from **subterranean termites.** These typically attack from tunnels in the soil but they don't always need soil. Sometimes subterranean termites infest wooden boats, marine piles and the very top storeys of high-rise buildings. All they need is food, moisture and a steady environment.

The next biggest threat are the **drywood termites**. These are the low-moisture specialists and they live in little colonies of at most a few thousand, often in one piece of wood. A single dwelling can have hundreds of these little colonies. They need warm areas with a bit of moisture and so are mainly tropical and coastal. Because they can't leave their bits of wood like subterraneans, they needs conditions to be suitable all the time.

The least common pests in modern housing are **dampwood termites**. As the name suggests, their preferred food is nearly always associated with excess moisture and some level of decay. Their food is usually too wet to be enjoyed by the other termite types.

Needs of termites

Termites need good food, moisture, warmth and a place that is constantly suitable for a nest or breeding site. Termites need time. They are not fast-acting pests like flies or cockroaches. The table below shows how the amount of moisture needed defines the three major pest termite groups: Dampwood, Subterranean and Drywood.

Moisture and food define termite risks

Termite type	Preferred food moisture (% by mass)	Timbers commonly damaged	Most common management approach
Drywood	Variable. Usually under 15%, to less than 6%, even 3%.	Framing, trims, doors, furniture and contents. Usually out of the sun so that temperature and moisture content change on slowly but where timber stays moist due to high humidity of the air.	Build with resistant, treated or disguised timber. Control with fumigant gas (no ongoing protection) or direct injection of insecticide.
Dampwood	Variable. Usually over 25% -35% but can survive dry	Usually decayed timber that is close to the soil or being	Plumbing, drainage and ventilation that avoids timber decay. Manage by removing water source and

	seasons.	wetted from a water leak. Timbers in a floor constructed on or near ground level are at high risk.	replacing damaged timbers.
Subterranean	Variable: usually 15 to 25% and will carry water to keep their tunnels and food moist.	Timbers which are not very dense and which can be reached from the soil. While they can carry water from the soil to the food, they prefer food that is already damp. In rare circumstances, some that fly into a structure above ground and find a mass of damp timber suitable can begin a new colony with no soil access.	Wide range of approaches mostly based on exclusion or making food unavailable. Design with measures to prevent concealed access from the ground and to make inspections and repair simple and economical.

Drywood termites usually get all their moisture from their food and their need for moist air makes them a significant risk in coastal and mountain areas of the tropics and sub-tropics. They are very good at conserving water and their faeces are hard pellets that often look like coarsely ground pepper. In many areas they are not considered a significant current risk but this may change over time.

Dampwood termites are so named because they need wood that has been wet enough to rot a bit (so wood that has spent some time being over one-third full of water) and even though dampwoods can survive short dry periods, they need substantially damp timber to thrive (approximately 25% +) and spread. They are associated with areas where the land was once heavily forested and do well in cool areas. Other than in traditional housing, modern structures are usually built to have few timber-wetting drainage issues which prevents most dampwood attack. Damp and decaying wood is most commonly caused by a drainage fault and fixing that and replacing the rot usually takes care of these termites. Sometimes to conserve water when it is scarce, the dampwood termites will produce faecal pellets just like the drywoods.

Subterranean termites form the middle group. They have the capacity to travel in tunnels through the ground sometimes even 50m from their nest, and they will often build mud tubes over non-food surfaces.

Subterranean termites need access to slightly damp timbers and can feed well at moisture contents around 16 to 25%. They can transport water from a remote source to bring their food up to the right water content and their mud tubes are kept constantly moist. Their faeces are usually wet and they will use this in a laminar pattern for constructing their nests and lining their tunnels. Some subterraneans, such as *Coptotermes*, may dig down into the ground and create cavities where they remove wet mud for construction. Subterranean termite colonies often grow to be hundreds of thousands of individuals.

Most structural termite risk comes from subterranean termites but drywood and dampwood termites can cause significant issues. We will concentrate on subterraneans first and then address drywood and dampwood termite risks.

Naming the parts of a structure at risk of termites	
Elements	The framing members and other parts that support a structural load.
Fittings	Timber or timber-like materials that are important but don't carry the loads. This includes trim timbers around doorways and windows, floor coverings, inbuilt cupboards and susceptible non-timber materials such as thermal insulation, electrical insulation, plaster and decorative details.
Contents	Furniture, artworks, decorations, stored materials, loose floor coverings *etc*.

The risk-reduction principles	
1. Nothing available to eat	Timber and cellulose products should be at least one of ▪ Inaccessible ▪ Too dry ▪ Not worth eating (wrong type or sometimes treated to reduce feeding risk)
2. Build to lower the risks	◦ Building design can reduce or eliminate termite risks. ◦ New buildings can be both at low risk of termite attack and cheaper to manage.
3 Safe under floor	◦ At the lowest level, either there will be no timbers in ground contact or only resistant timbers will used to support the ground floor.

	◦ Either a suspended floor with at least 400 mm clearance underneath for inspection or concrete slab flooring that termites cannot penetrate. ◦ Underfloor areas ventilated against moisture accumulation.
4 No concealed access	◦ Subterranean termites can be deterred by closing off all possible hidden paths from the ground into the building. ◦ Termites may still attack at the building's exposed perimeter but in doing this they are easily observed.
5 Easy to inspect	◦ A good design allows for elements and areas where termites may attack to be inspected without demolition.

Climate-based termite risk model*

This rating is based on climate averages		Available water		
		Dry	Moist	Wet
Climate	Cold	LOW	LOW	MEDIUM
	Cool	LOW	MEDIUM	HIGH
	Warm	MEDIUM	HIGH	VERY HIGH
	Hot	HIGH	VERY HIGH	VERY HIGH

* General guide only. Local factors will alter ratings.

DESIGN TO MINIMISE TERMITE RISK

A good low-risk design will:

1. deter termite attacks: it will provide an unsuitable environment for subterranean termites;
2. be resilient to damage by termites: the structural capacity can be maintained;
3. be readily inspectable: regular inspection can be expected to detect attacks before significant losses occurred;
4. be repairable: where termite attacks are expected, the structure will be designed so that repair expenses are minimised.

Design to reduce water retention

In general, any piece of timber stays moist for extended periods is at a high risk of damage by decay, and termites.

A good design will:

1. Have a roof with an overhang that helps keep rain off the exterior walls;
2. Have roof drainage so that rainwater is carried away for the perimeter of the building;
3. Be designed so that moisture in the building fabric is passively lost to ventilating air-flows;
4. Not have any timbers that are susceptible to termites and decay used in contact with the ground;
5. Have the immediate surrounds formed so that water drains away from the exterior walls and does not accumulate under or beside the structure.

1 As in the pictured pagoda, a good roof will protect the exterior walls and the footings from excess moisture. Ideally, the bottom metre of exterior wall will not be regularly wetted by rains or splashing.

2 Moisture in the soil around a building is a resource sought by any subterranean termites attacking that building. By increasing the distance to available damp soil, the building becomes less attractive to subterranean termites.

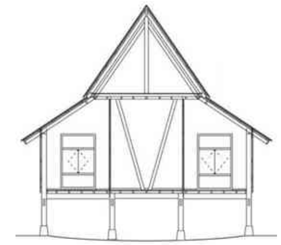
3 Termites prefer to eat timber that has been slightly decayed. A little bit of decay is believed to increase the food value of the wood. Wood decay fungi and bacteria typically need timber to be wet for them to get started and cannot grow in dry wood, so by allowing the breeze to remove excess water, the durability of the building is increased.

4 Timber in ground contact tends to retain moisture as there is little scope for drying. Ideally, no susceptible timbers would be close to the ground.

5 Water collecting under and around a structure is a strong driver of decay and termite activity. Particularly for a masonry or concrete construction, the perimeter footings must not be subject to water accumulation.

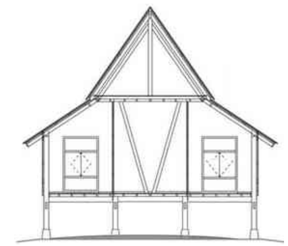
Elevated or suspended floors are easier to maintain

The risk of termite attack is greatly reduced if the ground floor is elevated. Houses on stilts, such as the classic Queenslander design are are well situated to catch the cooling and drying breezes, are resistant to minor flooding and have excellent access for replacement of stumps that rot or suffer termite damage without great disruption.
The photos below show two simple dwellings. In the first, the tall poles supporting the floor continue up into the walls. This makes replacement of failing supports difficult. In the second photo, the floor is separately supported and even though the building is dilapidated, repairs are relatively straightforward.



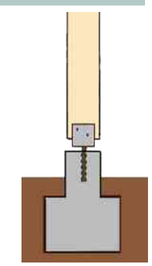
It is not always possible to achieve such elevations. Ideally a suspended floor will sit far enough above the ground that there is always room for an inspector to go fully underneath. No part of the sub-floor area should be fully enclosed so that it becomes inaccessible or lacks natural cross ventilation.

The soil beneath a suspended floor should formed, compacted and slightly domed so that it is not lower than the surrounding soil level and so that any surface waters drain away rather than ponding.



Timbers in ground contact or close to ground level are at increased risk

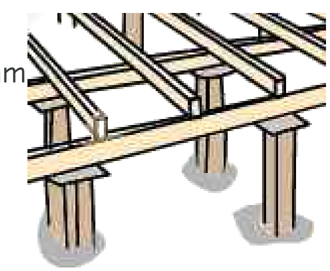
Timbers that touch the ground or are close to the ground will have a shorter service life unless the risk of decay and termites is reduced by specifying that timber in or close to the ground must be:



1. naturally durable against termites and decay, or
2. preservative treated (H3 or better), or
3. mounted above the ground level on metal stirrups or elevated solid concrete footings.

1 Naturally durable timbers may not be available or may be excessively expensive.
2 Preservative treatment can give normally non-durable timbers, such as pine, the capacity to provide extended service life.
3 Where it is not possible to avoid susceptible timbers at or close to ground contact, the design of the building should provide for easy access and replacement of these timbers as they degrade. Timbers on a metal stirrup should be mounted with a 20 mm clear gap underneath to allow the end of the timber to shed water.

Where timbers are used below the floor level and may be subject to termites or decay, the building design should allow for access to replace these structural members as required.



Ground level concrete is inherently termite resistant but must be done properly to exclude termites

Concrete can resist termites. To do so, it must be strong, solid (without trapped air) and reinforced or post-tensioned. Quality concrete with reinforcing that means no breaks or cracks are wider than 1 mm is generally impermeable to subterranean termites (some area have very small pest termites such as some *Heterotermes*, so local knowledge may mean adjustment).

Termite resistant concrete must be:

1. placed and vibrated or compacted to release any entrapped air – this prevents the termites using voids to gain concealed passage through the concrete;
2. specified and cured to avoid weakness by achieving a strength of at least 25 mPa as termites can pull particles out of weak concrete;
3. reinforced with metal mesh or post-tensioned so that no crack can exceed a width of 1 mm;
4. poured in one process so that no cold joints or other irregularities create unexpected gaps;
5. have any gaps at joints and penetrating pipes or conduits sealed – this means fitted with a collar, joint sealant or other termite management system so that termites are blocked;
6. continue across the building footprint or have the edges exposed so that termites going over or around are detectable.

Concrete at the building perimeter

While termites cannot pass through well-constructed concrete, subterranean termites will build shelter tubes that cover their access over it.

A concrete floor slab that extends to the building perimeter may create energy efficiency problems where the building requires heating or cooling for parts of the year to remain habitable. Concrete is a good transmitter of heat energy. Where this is an issue, the edge of the concrete should be enclosed.

For good termite risk management, the edge of the concrete will either be visible at the building perimeter (where it defines the inspection zone) or it will be securely attached to a termite-resistant sheet material that extends to be visible at the building perimeter and is embedded in or adhered to the concrete so that termite paths are blocked.

Mixed floor types can increase risks

If possible, mixed floor types should be avoided unless the design is highly termite resistant. A low suspended timber floor that attaches to a concrete floor (such as for a wet room) will have reduced ventilation and an increased risk of high moisture problems. Mixed floor types are not an issue when both are suspended above the ground by 400 mm or more and there is good airflow.

Interior waterproofing of wet rooms for risk reductions

Within a building, the term *wet room* covers any places where water is used. A kitchen, laundry, bathroom or toilet is a wet room. It is important that stray water not accumulate. Condensation on timbers or dampness that allows termites to collect water is a major risk factor. These rooms must be adequately vented. If windows cannot be left open, then fixed venting via powered fans is suggested. Where condensation persists for more than 20 hours, the risk of moulds and decay fungi increases. The floor and all areas of walls where water might splash or condense, should be fitted with some form of waterproof membrane. Wherever possible, the other side of walls and floors to which waterproofing has been applied should be vented so that any stray moisture can be lost to the air.

ACCESS FOR INSPECTION IS NEEDED FOR EARLY DETECTION

A structure that is at some risk of subterranean termite attack should be thoroughly inspected at least once each year and more often where the risk is high (see Table 7).

Inspection access is required for:

1. structural elements that may be at risk of termite damage;
2. areas of the structure where termites might gain concealed access;
3. the building perimeter;
4. the building interior;
5. any accessible roof and sub-floor voids.

Providing access for inspection means taking account of this need during design and construction.

To inspect under a floor, safe access requires a smoothed and cleared soil that does not collect water (pond) or retain enough water to waterlog the soil. The absolute best access to a sub-floor for inspection is to have the house elevated sufficient for a person to walk freely beneath. The clearance between the soil and any part of the floor framing or anything mounted or hanging below the floor should be at least 400 mm to allow an inspector to crawl safely (in some areas the legal minimum may be greater than this). To gain access beneath a floor, the inspector will need hatches at the perimeter or in the floor which provide a gap for safe bodily access of not less than 600 by 600 mm. The access hatch must lead into an area that is not horizontally obstructed for at least 1500 mm.

To inspect the spaces beneath a roof skin, the inspector must have safe bodily access which includes both entry and moving around. The horizontal framing members or other planks on which an inspector could stand must be not more than 1200 mm apart. The inspector will need vertical clearances of at least 1200 mm to inspect a roof void. The inspector must be given access hatches at providing a gap of at least 760 by 600 mm and framed to allow use of a ladder. Where these dimensions cannot be provided, then a series of hatches should be used so that the inspector can still view the entire roof area. Cathedral ceilings and other designs with no accessible void beneath the roof skin should be avoided unless other measures to reduce termite risk can compensate.

Metal foil roof insulation is widely regarded as an electrical hazard and it makes visual inspection of timbers largely impossible. Other form of loose insulation are preferred. Formed in place foam insulation is best avoided as it tends to reduce the capacity of timers to lose moisture.

Where a part of the building interior is at high risk (because of location, construction or water availability), any susceptible framing members should be made accessible for visual inspection. This can be achieved by having floor trims (skirting boards or baseboards) and door and window trims mounted with screws or bolts rather than nails or glue or by providing removable access ports in walls.

KEEPING THINGS VISIBLE: BLOCKING PASSAGES AND DEFINING INSPECTION ZONES

Where subterraneans termites are blocked from gaining concealed access to a building, they still have the opportunity to go up the sides of the blockage. To do this they need to build shelter tubes, also called surface mud tunnels, to provide protection from sun, dryness and predators as they travel. Shelter tubes are easily seen and identified. It is important that the edges of the block extend to places where inspection is possible. The oldest and most common inspection zone is created where a metal strip covers the top of a timber stump. Inspection zones are often created by attaching termite-resistant sheet material to the hidden edge of concrete floors and running the sheet out to the building perimeter where it remains visible (see). Inspection zones may also be defined where termite-resistant sheet passes right through a masonry wall, where metal stirrups are used to support posts and where a concrete slab edge is exposed. To a limited extent, the poisoning of soil beneath and around a structure may be thought of as creating an inspection zone at the soil surface.

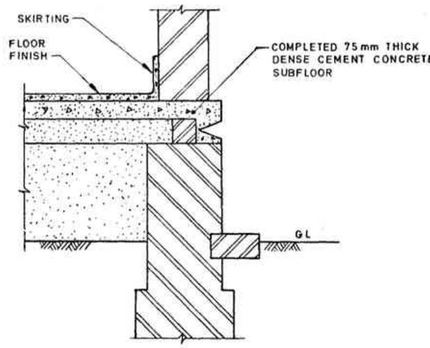


Fig. 6 Anti-Termite Construction — Stage 6

In Africa since the mid 1930s and in other countries, such as this drawing from an old Indian Standard, the use of a notched concrete slab edge is reported to deter termites building up the side of a building.

Where it is not possible to provide reliably useful inspection zones, it may be considered necessary to poison the soil against termite passage. If a reticulation system is placed into the soil so that the poison can be reliably and easily replaced, then it is possible to avoid a persistent poison that may cause significant off-site risks. Such a reticulation system may need additional soil poison every three to five years.

DAMPWOOD TERMITE MANAGEMENT IS STRAIGHTFORWARD

If a building is constructed to meet the aims of section , then it is highly unlikely that dampwood termites will ever become a problem. They would most like become a concern where the structure stays excessively moist due to a plumbing and/or ventilation failure. In each case, designed access for inspection and maintenance will allow detection, and he plumbing corrections and timber replacement that is all that is necessary to achieve control.

DESIGNING FOR DRYWOOD TERMITE RISKS

Construction to the principles of section will, to a large extent, reduce the risks of any drywood infestation resulting in undetected severe damage but they won't give total control.

When designing any structure it is important to ascertain the expected drywood termite risk and take account of it. Drywood termites live in their food, they cannot retreat into to the ground, and so they must find timbers that are always within their required temperature and moisture ranges. The various species of drywood termites span a huge variation in the temperature and moisture requirements. Some are borderline dampwoods and want timber that is slightly decayed and quite moist. Good construction and eaves can reduce their activity. Others drywoods, such as the West Indian Drywood Termite (spreading well in Oceania) do not tolerate wet wood and are almost exclusively found inside or under cover. Local knowledge is required to determine actual risk.

The simplest approach to avoiding drywood termite problems is to not have any susceptible timbers in the structure by building with (in order of preference)

1. naturally resistant timbers;
2. timbers sealed with a termite repellent coating;
3. preserved timbers;
4. not having any susceptible framing timbers such as by building only in steel or masonry.

It should be noted that inspection of structures for drywood termites is slow, laborious and quite expensive. Drywood termites may be present for many years before they are detected so proper design is important to reduce the risks of significant losses. Where there is a significant risk of drywood termite attacks, all concealed timbers should have resistance to termites.

A CHECKLIST

<<still under discussion>>

WHO ARE TIPRM?

The Institute of Pest Risk Management is a non-profit organisation that, since 2016, has been working to serve the field of pest risk management. We can be found at tiprm.com. Our main effort is to provide support for people with work roles to manage the impacts of pests. Our emphasis is to provide resources and support for the individual rather than the business. We provide training through a range of approaches, including Australian competency training through tme.edu.au

We are reachable via query@tiprm.com