# DRAFT ONLY
# Managing termite risk: core principles for construction

## PURPOSE

Termites can quietly cause damage that is entirely concealed before it becomes a structural risk. This is a guide to help people decide how to manage termite risks for new constructions. It is intended to help designers, builders, and planners. It is a general guide, written to identify and explain the risks as they present around the world. It gives broad design guidance for risk reduction and the use of specific measures to limit termite attacks. It is expected to be used in conjunction with local law.

**We are hoping to get it down to 8, easier, to read pages. This is prerelease version 0.94 a working draft saved June 4, 2022. Please check tiprm.com for the latest version.** 

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## THE RISKS:

Termite attack can render a building unsafe. Termites can damage framing, flooring, trim timbers, furniture, and a wide range of building contents. They eat woody things, so any material containing plant fibres is potentially at some risk. Termites will also damage non-food materials that get in their way such as soft plastic pipes, insulation, and even synthetic carpets. Sometimes the damage is just cosmetic. Our concerns are greatest where there is a safety risk or a major economic loss. Sometimes unmanaged termite attack makes it necessary to demolish a structure.

## 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. Choose long-life solutions with minimal service costs
5. Use a non-toxic or least-toxic approach whenever possible
6. Plan for efficient use of materials, energy, and any necessary pesticides
7. A good design will make most termite attacks readily visible
8. Good design reduces the cost of repairs after termite attack

## UNDERSTANDINGS

### What are termites?

Termites are organised insects. They form a branch of the cockroaches. Individual termites are small and fragile. Working in groups enables them to achieve great things. Only a few types of termite are pests of structures – most have important ecological roles. Pest termites live in colonies and are secretive animals which mostly avoid light and prefer to stay inside their food. Termites can be very hard to find. Their damage may build up for several years before it is discovered.

### Structural risks

Termites mostly act where they are hidden from view. They will consume the insides of load-bearing timbers leaving only enough to carry the static loads. Structural damage can result in unexpected failure. Heavily damaged buildings are more likely to fail when loads change, such as during events like windstorms and earthquakes.

### 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 and so can sometimes live in the building. Wooden boats and marine piles are also attacked. Like all pests, all they need is the right food, moisture, and a reasonably steady environment. Subterranean termite colonies often grow to be hundreds of thousands of individuals, and they can forage out around 50 metres from their main nest.

The next biggest threat are the **drywood termites**. These are low-moisture specialists. Drywood termites live in little colonies, of usually at most a few thousand individuals, and often live entirely within a single piece of wood. A building may contain hundreds of separate drywood termite colonies. They need warm areas with a bit of moisture but not too much. They are mainly tropical and coastal. Because they can't leave their bits of wood like the subterraneans, their colony needs conditions to be suitable all of the time. Drywood termite faecal pellets look a bit like coarsely ground pepper. In many areas they are not considered a significant current risk, but this may change over 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. An in a modern well-constructed and maintained structure, their attack is unlikely.

## Needs of termites

Termites need good food, moisture, warmth and a place for a nest or breeding site. Termites need time. They are not fast-acting pests like flies or cockroaches, and attacks can proceed over many years or decades. 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 moisture needs. 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.<br>Control with fumigant gas (no ongoing protection) or direct injection of insecticide. |
| **Dampwood** | Variable moisture needs. Usually over 25% -35% but can survive dry seasons. | Usually, decayed timber that is close to the soil or being wetted from a water leak. Timbers in a floor constructed on or near ground level are at high risk. | Keep timbers dry by using plumbing, drainage, and ventilation to avoid timber decay.<br>Manage by removing water source and replacing damaged timbers. |
| **Subterranean** | Variable moisture needs but they can bring their own water to wet the food and their tunnels. Usually, 15 to 25%. | 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 and so are often associated with internal leaks.<br>In rare circumstances, some that fly into a structure above ground and find a mass of suitable timber suitable can begin a new colony without any access to the soil. | 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.<br>Control infestations by poisoning colonies or by poisoning the soil under and around a building. |

### 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 worth eating** | Timber and cellulose products should be at least one of<br>• Inaccessible<br>• Too dry<br>• Indigestible, or not providing food value |
| **2 Build to lower the risks** | • Building design can reduce or eliminate termite risks<br>• 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<br>• Either a suspended floor with at least 400 mm clearance underneath for inspection or concrete slab flooring that termites cannot penetrate<br>• 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<br>• 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 seasonal climate averages | | Atmospheric moisture level | | |
| | | Dry | Damp | Wet |
| Temperature | 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 not 'reward' attacking termites with an easy meal;
2. be resilient to damage: the structural capacity survives termite attacks;
3. be readily inspectable: regular inspections can detect attacks before things get bad, but only if the structure makes this possible;
4. be repairable: where termites are likely to try and attack, the damaged parts of the structure can be repaired without major demolition.

## Design to reduce water retention

In general, any piece of timber that stays moist for extended periods will be prone to decay and termites.

A good design will:

1. have a roof with an overhang that helps keep rain off the exterior walls;
2. carry rainwater away from the perimeter of the building;
3. have venting to allow the building fabric dry quickly after wetting, with passive airflows which carry moisture away;
4. have any timbers in contact with the ground (high risk) be resistant to termites and decay;
5. have the surroundings graded and shaped 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 rain or splashing.

2 Subterranean termites prefer moisture in the soil close to a building under attack. The further these termites must travel to get their moisture, the less likely they are to sustain their attacks.

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

4 Timber in ground contact tends to retain moisture. Buried timber is slow to dry. Ideally, no susceptible timbers would be in or close to the ground. Good design allows for timbers at or near the ground to be replaced without compromising the structure.

5 Water collecting under and around a building is promotes decay and termite activity. Where a slope to drain waters away cannot be provided, design should supply a strong cross-flow of air so that the exposed ground dries.

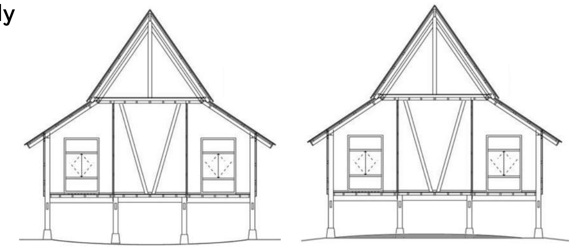
## Elevated or suspended floors are easier to maintain

The risk of termite attack is reduced if the ground floor is elevated. Houses on stilts, such as the classic Queenslander design, are well situated to (I) catch the cooling and drying breezes, (II) be resistant to minor flooding and (III), have excellent access for replacement of damaged subfloor timbers.

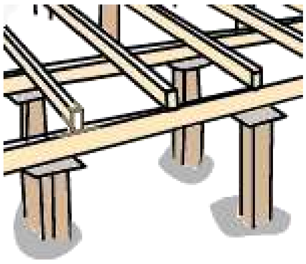
The photos below show two simple dwellings. In the first, the tall poles supporting the floor continue up into the walls. This makes replacement of failing supports difficult. In the second photo, the floor is separately supported and even though the building is dilapidated, repairs are straightforward.

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.



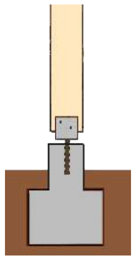
## Timbers in ground contact or close to ground level are at increased risk



Timbers that are close to the ground or touching it, will have a shortened 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 timber may not be available or may be unaffordable.
2 Preservation treatments can give normally non-durable timbers, such as pine, the capacity to provide extended service life. It is important that the right preservation technique is selected.
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 at least a 20 mm clear gap underneath to allow the end of the timber to shed water to the air.



Where timbers are used below the floor level and may be subject to termites or decay, the building design should allow adequate for access to inspect, assess and replace all of these structural members as required. A crawl space under a floor should have at least a 400 mm clearance for safe access.

## 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 excessive trapped air pockets) and reinforced or post-tensioned to limit cracking. Quality concrete with reinforcing can be designed to have no breaks or cracks wider than 1 mm and is generally impassable to subterranean termites (some areas have very small pest termites such as some *Heterotermes*, so local knowledge may mean adjustment to a smaller crack specification).

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 20 mPa, as termites can pull particles out of weak concrete;
3. reinforced with appropriate 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 unable to exploit the gaps that will form;
6. continue across the building footprint or have the edges exposed so that termites going over or around the edges 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. In cooler climates where heat loss is an issue, the edge of the concrete should be enclosed, and the system adjusted to still make termite attacks visible.

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 supplied with a termite-blocking system so that concealed entry is not possible. For example, a termite-resistant sheet material that extends to be visible at the building perimeter and is embedded in or adhered to the concrete, will act to block the termites, forcing them to climb up the building exterior.

### Mixed floor types can increase risks

If possible, mixed floor types should be avoided unless the design is otherwise 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 on page 5).

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 subfloor 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 still leave at least 400 mm clearance 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 500 mm on either side.

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, a series of hatches should be used so that the inspector can still access the void and 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 can carry electricity and so is widely regarded as a hazard for inspectors, and it covers surfaces, making visual inspection largely impossible. Other forms of loose insulation are preferred. Formed-in-place foam insulation is best avoided as it tends to reduce the capacity of timbers 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 and over 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 termites are pushed out to places where they can be seen. The oldest and most commonly used inspection zone is created where a metal sheet 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. 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.

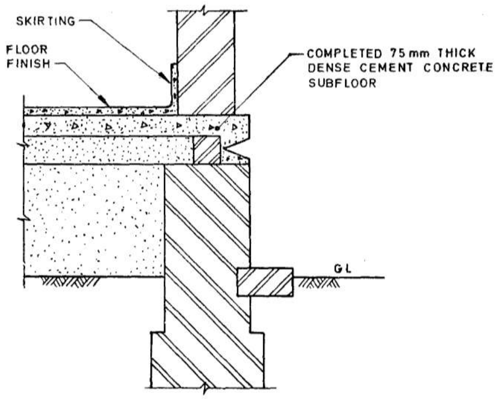



Fig. 6 Anti-Termite Construction — Stage 6

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. A pipe (reticulation) system may be placed into the soil around the building. Reticulation systems are designed and placed so that the poison can be reliably and easily replaced. Because reticulation allows for easy reapplication, an inexpensive, low-dose and less persistent soil poison can be used with the significant advantage of reduced 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 meet the principles outlined in this document, then it is highly unlikely that dampwood termites will ever become a problem. They would most like become a concern only where the structure stays excessively moist due to a plumbing and/or ventilation failure. In each case, designed access for inspection will allow early detection, and the good design will permit plumbing corrections and timber replacement to be economically made.

## DESIGNING FOR DRYWOOD TERMITE RISKS

If a building is constructed meet the principles outlined in this document, then to a large extent the risks of any drywood infestation resulting in undetected severe damage will be reduced.

When designing any structure, it is important to ascertain the expected drywood termite risk and make appropriate adjustments to ensure ongoing building performance. 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 risks and should be sought for input to any novel designs.

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 completely sealed with a termite-repellent coating;
3. preserved timbers;
4. no termite-susceptible load-bearing structural elements such as by specifying the framing to be built with only concrete, 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 DESIGNER'S CHECKLIST

Step 1: Assess local risks

Step 2: Design to address those local risks and the intended performance

Step 3: Ensure any proposed termite management system can actually be installed with that design and is not compromised by other features of the design or site

Step 4: Quality check the construction process

Step 5: Ensure any landscaping, paving & other site works support the termite management plan and do not compromise it

Step 6: Provide building owner/occupier with ongoing management advice and a point of contact for ongoing inspection

Step 7: Inspect structure and site at recommended intervals so that any problems can be addressed before significant losses occur

## 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 Your suggestions to improve this draft are eagerly sought, and once it is settled, we hope to offer several translations.

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