DATAsheet

MAY
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CONCRETE SLABS as Barriers to Subterranean Termites

INTRODUCTION

Following the banning in 1995 of the use of organochlorines as pesticides, concrete slab-on-ground floors have been recognised as part of the termite barrier in houses and other small buildings. It had been widely accepted that termites could not gain access through slabs complying with AS 2870 *Residential Slabs and Footings – Construction*[1] because of the inadequate width of any cracks likely to occur in them. There were, however, unsubstantiated reports that subterranean termites may have tunnelled through concrete slabs or widened existing cracks and thereby penetrated slabs thought to be impregnable.

This Data Sheet summarises the outcome of a three-year research project (funded by the Cement and Concrete Association of Australia and undertaken by the CSIRO) to ascertain through what crack widths in concrete slabs Australian termites could penetrate, and whether or not they could widen narrower cracks. It also discusses the major findings in the context of the requirements of the current Australian Standards for termite management.

A detailed report of the three-year research project is contained in *Concrete Slabs and Subterranean Termites*[2].

THE RESEARCH PROJECT

Over a three-year period from 1999, termite activity was assessed on test slabs placed in a tropical climate (near Darwin, NT) and in a semi-arid climate (near Griffith, NSW). In such locations, termites have a history of aggressive (but different) behaviour.

In each location, 300-mm-square by 70-mm-thick slabs using 20-, 15- and 10-MPa concrete were installed. A slab thickness less than the minimum allowed under AS 2870 (85 mm in WA and for waffle-pod slabs, 100 mm elsewhere) was used so as to give conservative results. An excessive amount of water was inadvertently used in the 15-MPa slabs for the Darwin site, resulting in a test strength of only 8 MPa. The specimens were, however, not discarded but used to provide useful information on the impact of high water-cement ratio (1.2 in this case) and low concrete strength on termite activity.

A STUDY conducted over a period of three years has shown that Australian termites need a crack width of 1.4 mm to gain access through a concrete slab.

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Figure 1: Test slab preparation and placement into position at exposure sites

A centrally located crack was made in each slab and its width fixed by means of a steel plate anchored to the concrete on either side of the crack. The cracks simulated shrinkage or temperature-induced cracks, which traverse the full thickness of slabs. A range of crack widths from 0.4 to 2 mm was used for each of the concrete strengths at both locations. Note that flexural cracks may occur in slabs but they do not extend through the entire slab thickness.

Simulated cold joints were also tested by joining two slabs together. Metal shims were used to give the required joint widths between the slabs, which ranged from 0.8 to 1.6 mm. In contrast to the cracks induced in the slab, these joints had straight and relatively smooth sides.

Centrally over each crack and cold joint a food hatch made from stainless steel mesh was bonded to the top of the slab **Figure 1**. The hatches were filled with blocks of *Eucalyptus regnans* which termites find particularly attractive.

Inspections were carried out one, two and three years after the installation of the slabs and a record made of termite activity at each site.

THE RESEARCH RESULTS

The study showed that:

- Australian termites need a crack width of 1.4 mm to gain an access passage through a crack in a concrete slab-on-ground. As concrete slabs constructed in accordance with AS 2870 are generally expected to have crack widths less than 1 mm, they can therefore be used as part of the termite barrier system.
- The termites needed to mud line all cracks through which access was obtained. This is most likely due to the abrasive sides of the crack and the fragile nature of the bodies of the termites. The need for this mud lining is probably the reason why crack widths need to be considerably larger than the measured head widths (or size) of the termites found in the study, and that are known to damage timber structures in Australia **Figure 2**.
- A more rigorous attack from termites was observed in the tropical (Darwin) than non-tropical (Griffith) climate. However, even under conditions of a wet/dry tropical climate and an abundant and diverse termite fauna, none of the cracks in concrete of the strength that should be used for typical residential floor slabs was widened. Only the slab made of 8-MPa concrete and a water-cement ratio of 1.2 had a crack widened. Cracks in the slabs with a nominal 10-MPa strength, but a water cement ratio of 0.83, were not widened.

Species	**Width** (mm)	**Height** (mm)
Mastotermes	2.8	2.8
Coptotermes	1.3	0.7
Schedorhinotermes	1.3	0.8
Heterotermes Validus	1.0	0.6
Heterotermes Vagus	0.8	0.5

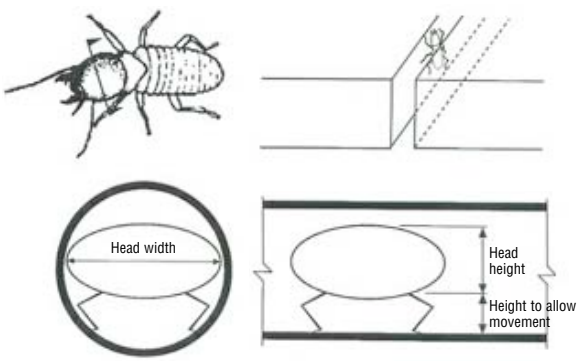


Figure 2: Size and head details of termites are critical factors for gaining access through cracks

- The termites inflicted only superficial damage on the underside of the test slabs and there was no evidence of them being able to tunnel through any of the slabs, even those made of the weaker concrete.

REQUIREMENTS OF AUSTRALIAN STANDARDS

Crack Width

AS 3660.1[3] considers that concrete slabs designed and constructed in accordance with either AS 2870 or AS 3600[4] can be used as part of the termite barrier system as crack widths will generally be limited to less than the I.0-mm maximum required by AS 3660.1.

The findings from this research project confirm that the 1-mm width is in fact conservative, as termites required a 1.4-mm-wide crack that extends the full depth of the slab to gain access through the slab. The research has also demonstrated that termites do not tunnel through concrete, and are unable to widen cracks (even those 1.2 mm wide) to gain entry into the building. Thus, crack widths exceeding 1.4 mm may still be acceptable in minimising the risk of concealed entry by termites, provided that they either do not extend the full depth of the slab, or that they reduce in width at some point to 1.2 mm or less.

An earlier study[5] carried out to determine the extent of cracking in residential slabs constructed in accordance with AS 2870, found that there were no cracks wider than 1.0 mm in size that extended the full slab depth. Only 7% of slabs had cracks in the range of 0.7–1 mm in width (well below the 1.4 mm research has shown is required to allow termite entry), and a third of slabs were uncracked. It concludes that for existing Standards and site construction practices, the level of cracking in residential slabs complies with the requirements of the Standards, confirming that they can be used as part of the termite barrier system.

Construction Details

AS 2870 provides standard design and construction details for residential slabs and footings. The importance of these details with regard to termites is that they will (as demonstrated above) ensure crack widths in concrete slabs are generally controlled to less than the 1-mm maximum required by AS 3660.1.

When constructing slabs in accordance with AS 2870, all the requirements, from the standard designs (particularly the reinforcement details) to the detailing and construction requirements, contribute to the control of cracking in the slab or footing. Regarding concrete and its placement, the standard specifies only the minimum concrete strength (20 MPa), a nominal maximum aggregate size (20 mm) and that it is to be transported, placed, compacted and cured in accordance with 'good building practice'. As more specific information is not given, the requirements of the Standard in this regard are often seen as open to interpretation.

'Good building practice' covers a range of quality issues, and there are numerous sources of information that relate to each of the areas mentioned in the Standard (transporting, placing, compacting and curing). Good building practices are important to ensure the design strength of the concrete is achieved and crack widths are controlled. They include:

- **Transporting** – delivering the concrete within the required time, thoroughly mixed and without any extra water added. Extra water can increase the extent and size of drying shrinkage cracks, weaken the concrete and cause dusting surfaces. Inadequate mixing can result in a variable water-cement ratio and possibly weaker areas of concrete.
- **Placing** – avoiding segregation and honeycombing, and not using the vibrator to move concrete around. These can provide weak areas, possibly containing voids.
- **Compaction** – removing any entrapped air (voids) within the concrete. Compaction will improve the concrete's strength, durability and resistance to drying shrinkage cracking.
- **Curing** – keeping the concrete continuously moist for a specified period of time. Curing will also improve the concrete's strength, abrasion resistance and reduce drying shrinkage cracking.

The above measures are simple to achieve and the benefits far outweigh any possible initial cost or time involved. The earlier study[5] into cracking of residential slabs confirms that by addressing quality issues such as compaction and curing, significant reductions in the crack widths (about 50%) can be achieved. By comparison, the study showed that increasing the steel percentage (say using SL82 instead of SL72 in a 100-mm-thick slab) only marginally reduced the crack widths (about 10%).

When designing slabs (including suspended slabs) and footings in accordance with AS 3600, due consideration must be given to controlling the crack widths so that they comply with the requirements of AS 3660.1.

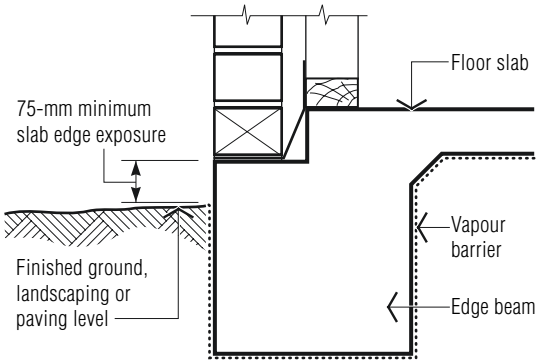
The Termite Barrier System

While the concrete slab provides an effective barrier to termite penetration, to complete the termite barrier system, any penetrations and joints through the slab, plus the slab edge must be considered, as these are the remaining locations that could allow

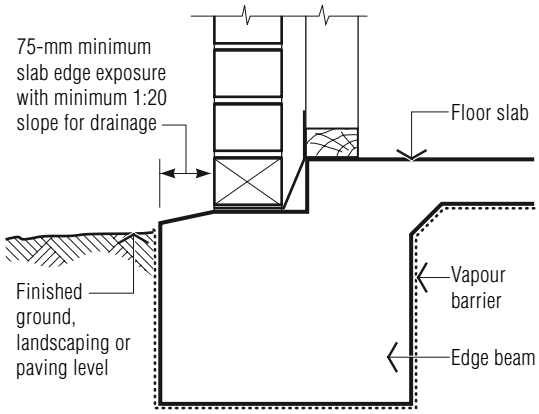
concealed entry of termites. Joints and penetrations are covered in Clause 4.3 of AS 3660.1, and slab edge exposure in Clause 4.4.

All penetrations through a slab-on-ground, and those in suspended slabs that can not be inspected, must be provided with a suitable termite barrier in accordance with AS 3660.1. This is because the gap that can open up between a pipe (or other penetration) and the concrete slab may be sufficient to allow termite entry. Similarly for joints, a suitable termite barrier may need to be installed depending on the type of joint, its location and whether or not it can be inspected.

To guard against concealed entry of termites around the perimeter of the slab, exposing 75 mm of the slab edge is probably the simplest and cheapest solution. This prevents concealed entry by creating an inspection zone that the termites must cross in order to enter the building. This inspection zone can be either vertical or horizontal **Figure 3**. The concrete face of the inspection zone should not have any rough areas, honeycombing or ripples that may allow concealed entry of termites, and should not be covered with any finishes that may allow concealed entry of termites.



(a) VERTICAL EXPOSURE



(b) HORIZONTAL EXPOSURE

Figure 3: Slab edge exposure for termites inspection (after AS 3660.1[3])

CONCLUSIONS

A study conducted over a period of three years has shown that Australian termites need a crack width of 1.4 mm to gain access through a concrete slab. For the concrete strength typically used in residential slabs and footings, no widening of cracks and joints, or tunnelling through the concrete, was possible.

Concrete slabs constructed in accordance with AS 2870 are generally expected to have crack widths less than 1 mm; other research into the cracking of existing slabs verifies this.

The results of a number of studies conducted over the years all validate the deemed-to-satisfy condition in AS 3660.1, that is, concrete slabs designed and constructed in accordance with AS 2870 or AS 3600 can be used as a termite barrier.

REFERENCES

1 Standards Australia, AS 2870 *Residential slabs and footings – Construction* 1996

2 Schafer, B and Guirguis, S, *Concrete Slabs and Subterranean Termites*, Paper presented at the CIA Biennial Conference, Brisbane 2003

3 Standards Australia, AS 3660.1 *Termite management Part 1: New building work* 2000.

4 Standards Australia, AS 3600 *Concrete structures* 2001.

5 Potter, RJ, *Cracking in residential slab-on-ground floors and footings*, Cement and Concrete Association of Australia 1995.

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CCAA OFFICES

SYDNEY OFFICE:
Level 6, 504 Pacific Highway
St Leonards NSW Australia 2065
POSTAL ADDRESS:
Locked Bag 2010
St Leonards NSW 1590
TELEPHONE: (61 2) 9437 9711
FACSIMILE: (61 2) 9437 9470

BRISBANE OFFICE:
Level 14, IBM Building
348 Edward Street
Brisbane QLD 4000
TELEPHONE: (61 7) 3831 3288
FACSIMILE: (61 7) 3839 6005

MELBOURNE OFFICE:
2nd Floor, 1 Hobson Street
South Yarra VIC 3141
TELEPHONE: (61 3) 9825 0200
FACSIMILE: (61 3) 9825 0222

PERTH OFFICE:
45 Ventnor Avenue
West Perth WA 6005
TELEPHONE: (61 8) 9389 4452
FACSIMILE: (61 8) 9389 4451

ADELAIDE OFFICE:
Greenhill Executive Suites
213 Greenhill Road
Eastwood SA 5063
POSTAL ADDRESS:
PO Box 229
Fullarton SA 5063
TELEPHONE: (61 8) 8274 3758
FACSIMILE: (61 8) 8373 7210

EXTRACTIVE INDUSTRIES OFFICE
PO Box 243
Henley Beach SA 5022
TELEPHONE: (61 8) 8353 8151
FACSIMILE: (61 8) 8353 8151

TASMANIAN OFFICE:
EXTRACTIVE INDUSTRIES OFFICE
PO Box 246
Sheffield TAS 7306
TELEPHONE: (61 3) 6491 2529
FACSIMILE: (61 3) 6491 2529

WEBSITE: www.concrete.net.au

EMAIL: info@ccaa.com.au

LAYOUT: Helen Rix Design