TRAINING & INSTALLATION MANUAL
WELCOME

PC Plastics offers you a most sincere welcome and trust you will enjoy becoming part of the team.

At PC Plastics we insist on the highest standards of workmanship. This manual and the associated Training Program will provide you with the essential knowledge and skills to be able to attain these standards and excel in your career.

As you progress through the Training Program please ensure your understanding is complete by asking questions and participating in the practical sessions.

As an installer your performance will be monitored through our Quality Assurance Program to determine if your training has been competently interpreted for installations on site.

Deliberate deviations from the accepted specifications will result in an adverse result, and may place in jeopardy your accreditation as an installer.

All Installers of the Biofilm Termite Barrier System are expected to introduce their own quality assurance program consistent with the requirements of the Warranty and those relevant procedures detailed in the Operational and Policy Manual.

Congratulations on your involvement with Biofilm and best wishes.

With kind regards,

BIOFILM

PC Plastics
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PURPOSE

This Training and Reference Manual has been prepared for Installers as a reference on the various techniques associated with the installation of Biofilm Termite Barrier System.

This Manual is the standard by which PC Plastics will accredit installers and conduct quality assurance programs. Quality assurance ensures the highest standards of performance are maintained as there can be no compromising on either the quality of workmanship or the materials used.

This Manual is also the vehicle by which advances in installation techniques are communicated consistently to all those involved in Biofilm Termite Barrier Systems Installation through regular updates.

Installers are encouraged to offer comments, concerns, problems, and wherever possible solutions on any aspect of the process of building out termites with the best termite control system – Biofilm.
OBJECTIVES

The objectives of this Manual and associated training program is to ensure Participants;

Session One  Develop an understanding of termites and the alternatives to Biofilm.

Session Two  Develop an appreciation the concept of building out termites with Biofilm, including an understanding of the research and testing programs completed, and the recognition received. Also including the role of concrete in building out termites.

Session Three  Develop the essential skills and knowledge necessary to competently install Biofilm to specification.
Session One

Understanding Termites

Objective: To develop an understanding of termites and the alternatives to Biofilm products.
Understanding Termites

Introduction

Termites are an Order of insects that have existed for many millions of years with the most ancient species around in the time of the dinosaurs.

Termites are often referred to as ‘white ants’ but are more closely related to Cockroaches. Both termites and cockroaches have been amongst the longest surviving INSECTS in the world and obviously can adapt to changing environments.

One thing termites do have in common with ants is that they are social insects and live in colonies. Social insects always work and operate for the good of the colony and are willing to sacrifice themselves to help the colony survive.

The prime source of food for termites is cellulose, which is predominantly found in timber. Termites can eat dried timber, rotting timber and living trees. Termites are extremely tenacious in finding timber even though those scouting for food are blind. If timber is present, termites will find it.

It was estimated in 1986 that termites caused in excess of one hundred million dollars damage to houses in Australia each year, even though they are supposedly protected from termite attack.

No insurance company in Australia currently provides insurance against termite attack due to the frequency and cost of termite damage. The cost of maintaining protection of a house against termite attack on an annual basis is typically equivalent to the cost of insuring the house against all other damage that may occur.

Hence, it is extremely important that any installer of the BioFilm Termite Management System has a good understanding of the habits of termites and how they can enter a house in order to effectively prevent unconcealed entry from occurring.

Flying Ant

Elbowed Antennae
Pinched Waist
Unequal Length Wings

Flying Termite

Straight Antennae
Thick Waist
Equal Length Wings
The following sections in this manual provide limited technical information on termites which is useful background knowledge, but an understanding of the habits of termites is critical to ensure that a component of the Biofilm Barrier is installed at every point a termite might access a building.

The information provided has essentially come from the below reference texts:


**Order of Termites**

As discussed earlier, termites are one of the Orders of insects: Termites are the only insects that make up the Order Isoptera.

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INSECTS

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The Order Isoptera can then be further divided into the following seven families and fifteen Genera:

**ISOPTERA**

- Mastotermitidae (Family and Genera)
- Kalotermitidae
- Termopsidae (Family)
  - Termopsinae (Genera)
    - Porotermitinae
    - Stolotermitinae
- Hodotermitidae
  - Termopsinae (Fossil)
  - Hodotermitinae
- Rhinotermitidae
  - Psammotermiteinae
  - Heterotermitinae
  - Stylotermitinae
  - Coptotermitinae
  - Rhinotermitinae
- Serritermitidae
- Termitidae
  - Apicotermitinae
  - Termitinae
  - Wcrotetermitinae
  - Wcrotetermitinae
  - Nasutitermitinae

The different Genera are clear cut and well defined. The Genera can then be further differentiated into species and subspecies by slight variations in the appearance and chemistry of the termites. For example the Genera Coptotermitinae have many species represented as Coptotermes spp or a single species Coptotermes acinaciformis or the subspecies Coptotermes raffrayi.
Currently the number of termite species around the world is approximately 2,500 with about 350 in Australia. As subspecies can now be determined by advanced chemical techniques the number of termite species and subspecies is likely to further increase with time.

The majority of termite species found in Australia occur in the tropical and subtropical regions with still a significant number of species occurring in the warmer temperate regions. Even Tasmania has three species of termites, but these species are not associated with causing damage to buildings. Termites are, however, causing more damage in areas previously associated with low termite activity, for example Canberra and Melbourne, because of the suitable local environment being generated by modern housing design.
If installers require more detailed information on the location of termite species in Australia, the following reference provides excellent details:

Available in Ebook Edition from Booktopia
Cost: - $56.50

**Termite Colonies and Castes**

All the known species of termites form and live in colonies, which may be comprised of hundreds of thousands, even millions, of individuals, though they are usually much less populous.

The mutual cooperation that forms the basis of their society neutralises the weakness and defenselessness of most of the individuals in the colony. This also enhances the speed, scope and efficiency of the termites’ activities, and hence immeasurably increases their destructive powers.

The above referenced mutual cooperation between the various members of a termite colony is based on a division of labour and the existence of physically distinct types – the castes – each specialised to perform certain functions for the good of the community as a whole. The most important feature of this division of labour is the restriction of the function of reproduction to a few individuals – often to a single pair – and the sterility of the great majority of the member of the colony.

Every termite colony contains workers, soldiers, juvenile forms, and at least one pair of reproductives, which are usually referred to as the king and queen.

At certain times of the year winged forms, or alates, are present in the colony. These develop through a nymphal stage, which has wing-buds. Nymphs are present in the colony for a varying period prior to the appearance of alates.
The workers constitute the great majority of the population of a termite colony (approx 90%). They are of both sexes and are wingless, sterile, and blind. Workers have round, usually pale-coloured heads, and soft unpigmented bodies. They rarely appear white, because the gut contents and the internal organs are usually visible through the semi-transparent skin. The workers are named as such as they build the nest and the galleries, tend the eggs and the young, act as scavengers, gather food, and feed those of the other castes that cannot feed themselves. Once a colony is founded the workers are indispensable members of the community, and they alone are responsible for damage to timber.

The soldiers, like the workers, are of both sexes and are wingless, sterile, and blind. They can be distinguished from workers visually by their heads, which are strongly pigmented and, with very few exceptions, are very much larger than those of the worker and other castes.

Soldier termites may be either “mandibulate” or “nasute”. Mandibulate soldiers have large, prominent and often grotesquely developed jaws. Nasute soldiers (which are confined to the single Genus Nasutitermitinae) have vestigial mandibles – meaning that their heads are flask-shaped, being drawn out anteriorly into a snout or “nasus”, at the point of which opens the pore of the so-called cephalic gland.

Owing to the extreme enlargement and specialisation of the mandibles as fighting weapons, or their reduction in the nasutes, the soldiers of most species of termites are incapable of feeding themselves, and thus depend on the workers for their nourishment.

The heads of soldier termites are different for each species. The different shaped heads, size of the head and the size and shape of the mandibles allows the identification of the different termite species.
The primary function of the soldiers is to defend the community, chiefly against ants, which are the termites’ most serious enemies. Sightless and slow-moving, in the open they are usually no match for these marauders; but when fighting on their own ground, say in a breach in the nest or galleries, soldier termites can often hold ants at bay.

The cephalic gland, mentioned above, is greatly developed in the soldiers of certain termites, and secretes an irritating, offensive, or sticky secretion that is used to augment the effect of the mandibles. Nasute soldiers rely solely on methods of chemical warfare. The cephalic secretion, which is forcibly ejected from the end of the snout, forms a sticky thread that is very effective in entangling the legs of insect enemies.

The life expectancy of workers and soldier termites is about four years. This is a very long time for an insect to live, especially for the lower castes. The worker and soldier castes are the products of suppressed and specialised development.

In the Isoptera the “perfect insect” or imago is represented by the alate, or winged reproductive caste.

The alates are the potential kings and queens of future colonies. They have no duties to perform in the colony in which they are reared, as their reproductive function is not called into play until they set about founding colonies of their own.

The alates are completely different in appearance from the workers and soldiers. Their bodies are pigmented (often being very dark-coloured); they have well developed compound eyes and generally a pair of ocelli also; and they have four long wings, of which the front and hind pairs are similar in size and venation; hence the name Isoptera for the Order (from the Greek isos equal, pteron a wing).

Near the base of each wing there is a line of weakness, the basal suture, at which the wing is deliberately broken off after the colonising flight. A de-alated insect can be recognised by the four short wing stumps on the thorax.
The King alters relatively little in appearance during his lifetime. The Queen however, becomes gradually transfigured as her ovaries enlarge and she becomes a more and more efficient egg-laying machine. In all termite queens the abdomen becomes noticeably swollen; but in species of the two highest Families (the Rhinotermitidae and the Termitidae) it becomes relatively enormous. A physogastric queen is too large to move or be moved easily through the galleries of the nest; and she will generally, although by no means always, be found in a specially constructed cell, sometimes attended by the king and a retinue of soldiers and workers.

Many, if not most, species of termites are able to produce supplementary or neoteinic reproductives. These are essentially nymphs that develop functional reproductive organs without becoming alates or leaving the parent colony. The role of neoteinics in the economy of termite colonies, and the conditions that lead to their development in representatives of the different Families, are not fully understood. Their primary importance is obvious enough: they enable a colony to continue and to flourish when the true king or queen has died, either from old age or as the result of an accident.

One of the most difficult things to explain in connection with neoteinic reproductives is that they are never found in certain species, even though they are developed in other species of the same Genus. Neoteinics occur so generally among the Isoptera that it must be concluded that the faculty of producing them is one of the most ancient characteristics of termites, and that those species in which they do not occur have somehow lost the power of developing them. Why a facility of such biological value should have been discarded is very puzzling.

The Foundation & Age of Colonies

A termite colony is no more than a specialised family group of parents and offspring living together; and new colonies are founded in a manner essentially similar to that in which new families are established in our own species. A male and a female, having left the parental home, mate, settling down in a home of their own, and proceeding to rear children.

In the termites, the departure of the young reproductive from the colony in which they were reared takes the form of a mass exodus known as the so-called swarming or colonising flight. The workers prepare for the emergence of the alates from the nest or galleries inhabited by the colony by constructing special openings to the surface, which are sealed up as soon as their purpose has been served.
The flight of the winged forms is a well-known phenomenon, because it is often quite spectacular, and because the termites, during their brief existence as free-flying insects, lose their instinct to seek the darkness, and may even be strongly attracted to lights. The flight usually takes place during the summer months, either just before, or more often, just after rain. Alates are often called flying ants even though they are termites. When they land after their first and only flight, the alates shed their wings and pair off. Immediately after a flight, de-alated pairs can be seen running over the ground, the bark of trees, or logs and stumps, the male following so closely behind the female that the two appear to be coupled head-to-tail. Males find the females by a special chemical smell that they produce. The first act of a newly established royal pair is to seek out a suitable spot in which to rear their brood; and according to the habits of the species to which they belong, they will burrow in the soil, crawl into the crevice of a log, or eat their way into a stump or the dead wood of a growing tree. Before the actual mating and egg-laying take place, the young king and queen excavate a chamber in the wood or soil, the entrance to which is carefully blocked.

Here, the first brood is hatched. In their early stages the young are fed by either of the parents, apparently on the secretion of the salivary glands. As soon as they can shift for themselves, workers start to forage and to excavate galleries. From this time on the queen depends on them for nourishment, and her fecundity increases (egg laying capacity).

It is difficult to estimate the normal length of life of a termite colony. In those species which habitually produce supplementary kings and queens, the colony is potentially immortal.

Generally speaking, it would be safe to say that in those termites which form communities with a population of hundreds of thousands, the life of a colony must run into several decades and is most likely to live for about fifty years. A colony does not reach maturity for about twenty years and at this stage it is likely to have about one million termites in the colony. A mature colony produces about 50,000 alates per year, so over the life of a colony it would have released about one million alates. Obviously to keep the status quo only one pair from these million alates actually manages to bring a colony to maturity.
Termite Categories

All termite species can be categorised into four main groups depending on their habits:

(i) Subterranean Termites
This group of termites have colonies that are either underground or in the base of trees, with tunnels (galleries) radiating from the nest through the soil to food sources. Workings between the soil and above-ground food sources is concealed in mud-like shelter tubes or galleries. This group of termites are the most damaging to buildings (more that 95% of all damage).

(ii) Dampwood Termites
These are only found in timber that is affected by moisture and is subject to fungal decay. This timber may be rotting branches in trees or stumps of houses that are moisture affected.

(iii) Drywood Termites
They only nest in tropical or sub-tropical regions of Western Australia. These termites do not require contact with the ground and moisture is obtained directly from the timber. These termites do not cause as much damage as subterranean termites and colonies are much smaller in number.

(iv) Harvester (Grass) Termites
These termites eat grasses and are most common in tropical regions. They are no threat to buildings.
Termite Nests, Termites and Moisture

According to their habits, termites can be divided into the four well-defined groups, mentioned above. Many of the subterranean termites feed on wood, often at a considerable distance above the ground. Their attacks always originate from the soil, under the surface of which run the galleries that link the various food supplies to the central nest. The central nest may be up to 100 metres from the food source - a long way in suburbia. Thus an essential feature of the workings of a subterranean termite in timber structures is the maintenance of a ground connection, by means of which the foraging parities keep in communication with the reproductive centre of the colony.

The great majority of Australian termites are subterranean. When a nest (i.e. a specialised concentration of galleries and chambers) is formed, most often in wood-eating species, it will be located at the base of a stump, pole, or fence post, or, more rarely, somewhere in the soil beneath. Again the nest may be raised above the surface of the ground in the form of a mound; and in one or two species it may be attached to the trunk or limb of a tree (Aboreal). Aboreal nests are always connected with the soil by galleries running down the surface of the trunk; and they appear to be formed only when a colony has reached a certain size, after some years of subterranean existence.

The most consistent and characteristic habit of termites is the shunning of light and their voluntary confinement within a completely enclosed system of intercommunicating galleries and covered ways. Under normal circumstances the galleries inhabited by a termite colony will only be in open communication with the outer world when the winged forms are emerging, or while repairs or new construction is being undertaken. When feeding on timber above the ground, if they are attacking it from within, termites will refrain from eating away the outer layers; and if they are feeding on the surface of the wood they will work under a roof-like shelter, which may take the form of irregular patches of “plastering” or of narrow covered ways (“tubes”). According to the species of termite, the material used in this plastering and tube construction may be either cemented soil or what is termed “carton”, which seems to consist largely of semi-digested wood and organic matter. Often soil particles will be incorporated in the carton; and sometimes earthy structures may be built by a colony at one point, and carton galleries at another.

The termite nest needs to be kept at constant temperature and humidity for survival. The ideal temperature for the inner core, which contains the queen’s chamber and nursery, is about 28° to 30°.

The outer layer of the nest will vary to be cooler or hotter depending on the external environment. Nearly always in large colonies with centrally concentrated nests there is a large production of metabolic heat and carbon dioxide which must be dissipated.
Different venting systems are used to expel the carbon dioxide and, evaporation of water cools the nest like an evaporative air conditioner. Obviously varying the air flow would change the temperature.

The ability to control, even if only to a limited extent, the humidity of the atmosphere in their galleries is of great importance to insects with a thin integument that are exceedingly sensitive to moisture changes. In surface tubes and isolated soil galleries it is unlikely that the humidity could be maintained, at any rate for long, at a level much above that of the surroundings. But where a concentration of galleries is found, as in a nest, a very real control of atmospheric humidity can be, and is, obtained. Investigations have shown that in the central portion of the mound – the moisture present in the nest atmosphere is derived partly from the surrounding environment and partly from the respiration of the insects themselves.

The examples that could be cited to illustrate the importance of humidity as a factor governing the movements, habits, and even the distribution of termites are almost innumerable; for anyone studying these insects is confronted with them at every turn. Particularly in dry weather, as might be expected, termites are strongly attracted to free moisture; and a slight leak in a water main often leads to a congregation of the insects in the damp soil. Much the same thing happens in termite-infested buildings. In places where water is continually being spilled, or near a leaking drainpipe, concentration of galleries will often develop. Termites very frequently attack bathrooms and laundries because of this situation. As the humidity of the surface soil and the air is subject to great variation, and in many parts of Australia must drop to, and remain at, a very low figure for considerable periods, subterranean termites must, and in those species that construct moisture-conserving nests, the workers and soldiers can always return to them and enjoy a spell, so to speak, in a humid atmosphere.
Probably it is only in this way that they are able to continue foraging in places where the humidity is too low for their well-being. Subterranean termites are known to go to great depths, usually following tree roots to find “free” water (ground water). Without this supply of water the termite colony will perish. Obviously in arid and semi-arid regions termites will go to greater lengths to find water.

Termites are known to become more active and attack timber after significant rain has occurred. It is during this time termites can forage more easily and have sufficient moisture to construct new galleries. In the tropics termites are active nearly all year, while in semi-arid areas their major activity is usually restricted to just after the wet period.

The Diet of Termites, Cellulose Digestion and Cannibalism

Contrary to popular belief, wood is not the natural food of all termites. Many species obtain the cellulose, which is the basis of their diet, from sources other than wood. In fact, a very large proportion of the total number of species found in Australia are grass and debris feeders; and of the wood eating species, relatively few habitually attack sound seasoned timber, the majority feeding on living trees, on rotten wood, or on weathered wood surfaces only. The readiness with which a sound-wood eater attacks a particular timber depends upon factors such as the moisture content of the wood, its physical qualities of density and hardness, and on the presence in the wood cells of substances, generally known as extractives, that may be either repellent or actually toxic to the termites.

Although the feeding habits of most species of termites, living under natural conditions, are fairly stereotyped, many at times display considerable adaptability, and will attack a variety of substances and materials, including some that contain no cellulose.
Rather surprisingly, termites lack the specific enzymes (celluloses) necessary for the breaking down of cellulose; and for the digestion of this major component of their diet they depend on the cooperation of micro-organisms that are found in immense numbers in the enlarged hindgut. In the Termitidae it is possible that bacteria may perform this function. In all other Families of termites cellulose digestion is carried out by protozoa. The digestion produces the by-products of carbon dioxide and methane. The large quantity of methane produced by termites may be used to detect their presence by special electrical equipment.

Cellulose, being a carbohydrate, does not provide all the elements needed for the production of living tissue and the maintenance of life. The sources from which termites obtain the proteins they require are still, to some extent, open to speculation. Fungal hyphae may be an important source of protein for termites. It has often been suggested that termites cannot live on fungus-free wood, and that apparently sound wood contains fungal hyphae, if not when first attacked, at any rate shortly after the termites have started feeding, since they act as infecting agents. The habit of cultivating fungi as food, in special chambers in the nest, is widespread amongst African and Asiatic species of the Family Termitidae, but is not found in any of our Australia's termites.

Linked with the dietary requirements of termites is the phenomenon of cannibalism, which is now known to be encouraged by protein starvation. An observation made at Canberra suggests that cannibalism may be the method employed by termites to remove from the community individuals that have become superfluous. Although it has been amply demonstrated that termites have no objection to eating one another, it is known that termites habitually eat their dead - an assertion that will be found in many general works on these insects. Certainly the habit of disposing of dead, moribund, and otherwise useless members of the community by eating them would be a simple and effective form of protein conservation.

One other aspect of termite feeding habits that must be mentioned is the grooming of their own and their nest mates' bodies by licking. This grooming habit is widespread amongst termites and is associated with their eagerness to obtain the glandular secretions that are exuded over the body surface. During the course of grooming, any dust particles that may be adhering to the body surface are removed and ingested, so that this habit plays an important role in the poisoning of termites in control operations. If finely powdered toxic material is introduced into termite runways, particles of the powder will adhere to the bodies of the termites and will kill any termites that subsequently groom and dusted individuals. In this way the poison is distributed through a colony and kills its members.
Termite Entry into Buildings

As stated earlier, nearly all termite damage of buildings in Australia occurs from subterranean termites. In the southern half of Australia only subterranean termites are a problem. Worker and soldier termites, even though blind, are ingenious at finding ways into buildings without being detected. Subterranean termites can build galleries or mud tubes underground with relative ease. The depth of the galleries is typically in the top 30cm of soil. It is believed that about 80% of termite attack of buildings originates from termites gaining entry from the perimeter and attacking wet areas (e.g. laundry, bathroom). The entry point is typically just below the surface of the ground.

There are two reference books which should be consulted for entry points of subterranean termites into buildings:


The determining of potential entry points of termites could be considered an art or skill. The National Pest Control Association and Building Out Termites by Verkerk has many diagrams showing potential entry points of termites. It is extremely important that the Biofilm Termite Barrier System protects all potential entry points of termites into buildings.

Later in this Manual you will be presented with the correct techniques for this protection for most construction designs. Every building design should be carefully checked to determine entry points. One area sometimes forgotten is retaining walls inside buildings. This is a common entry point of termites.
Vigilance Is The Key To Termite Protection

As stated earlier, termites are attracted to areas of moisture because without it they cannot survive or expand the colony. In the vast majority of houses wet areas such as laundries and bathrooms are not tanked or waterproofed which allows moisture to penetrate the concrete slab and seep into the soil. Termites are attracted by this moisture and will investigate possible food sources above.

Wet areas also have many penetrations through the concrete slab, which allows the termites easy access. Hence when termite attack does occur in a house it is most likely in the laundry or bathroom areas. Other areas of high moisture, like leaking downpipes or overflows from air conditioners are also very attractive to termites. Anywhere there may be a fairly regular supply of moisture is prone to termite entry.
Session Two

Biofilm and Termites

Objective: To develop an appreciation the concept of building out termites with Biofilm, including an understanding of the research and testing programs completed, and the recognition received. Also including the role of concrete in building out termites.
Overview

- Presentation on the principles of Biofilm reinforced by site inspection.
- Review research and testing programs with particular reference to the recognition received.

Principles of Biofilm
(Manual and Brochures)

What Is Biofilm?

Biofilm is a physical termite risk management measure that is flexible in nature and is classed as a chemical barrier in a non-soil matrix. It is a once only treatment that is designed to last the economical life of the building.

Biofilm Perimeter Protection

Biofilm is installed to areas of the building where termites may ingress. The Biofilm System is designed to force out the undetected entry of termites where their earthen tunnels and galleries are readily detected. The onus is on the owner to be vigilant in maintaining a clear 75mm visual inspection zone (see maintenance and guidelines) in conjunction with regular competent inspections from a qualified Biofilm accredited inspector not exceeding 12 months to comply with warranty terms and conditions.
The Biofilm System works in conjunction with the concrete slab being poured to AS 2870-2011 which forms an integral part of the termite risk management measure by using the concrete slab as a physical barrier complying with AS 3660.1-2014 Section 4.4.

Biofilm in Cavity Walls for Typical Strip Footings & Raft Slabs

Option A

Option B
Understanding Concrete and Cracking

It is important Installers understand the basics about concrete and its potential for cracking. The issue of cracking is raised by most people assessing the use of the Biofilm Termite Barrier System.

What is Concrete?
The term concrete is a generic term that does not have an exact definition. The composition of concrete is typically:

- 4 parts aggregate
- 2 parts sand
- 1 part cement

The aggregate is a crushed stone (for example dolerite) of about 15mm in length. The more angular the edges of the crushed stone the better it is supposed to perform. The sand should be angular (sharp) if possible and not contain shell grit. The sand from a quartz source is the best. The cement is nearly always a Portland cement, which has to meet specific composition. The finer the cement particle the better it performs (for example Portland Type A or Type B depending on the strength required).

How Does Concrete Cure?
Cement reacts chemically with water to form a cross linked stone like matrix that is extremely hard but brittle. The crushed stone aggregate and sand give the concrete strength as well as hardness.

The reaction between cement and water is exothermic i.e. generating much heat. The temperature of curing concrete can rise to 600ºC or higher especially when there is a large mass of concrete. This rise of temperature on curing is the reason plastic pipes typically develop a crack between the perimeter of the pipe and the concrete when the concrete has cured. The plastic pipe has a high coefficient of thermal expansion and when the concrete cools down the plastic pipe shrinks away from the concrete leaving a crack which termites are often able to enter.

Concrete when poured and placed typically takes about 4 hours to achieve sufficient hardness to enable the concrete to be floated off with a trowel or helicopter trawelling machine.

In the process of the concrete curing, excess water bleeds to the surface through capillaries that form in the concrete. These capillaries are extremely fine and cannot be seen by the naked eye. It is extremely important in terms of the strength and durability of the concrete that the number of capillaries and size of the capillaries is kept as small as possible. Concrete usually reaches most of its strength in the first 30 days but will continue to harden for a very long time if water is available to the cement after those 30 days. However the addition of excess water to the concrete before being poured does not improve its strength – it actually has a detrimental effect of increasing the number and size of capillaries.
Correct Curing of Concrete
Strong concrete is achieved by correct curing. A range of different methods can achieve this, but they are based upon reducing the rate of evaporation of water from the concrete. Some of the ways of correctly curing concrete is to:

- Continually spray the concrete with water for several days after pouring.
- Build a levy around the floor out of sand or alike and flood the floor with water for several days.
- Spray a thin layer of plastic (PVA chlorinated rubber) over the concrete within several hours of the concrete being leveled.
- Covering the concrete with light coloured plastic sheeting (apparently the best)

Grade of Concrete
As discussed earlier concrete is a generic term and concrete can be provided in different qualities and properties.

The most important factors in final concrete strength are.

- Amount of cement
- Amount of water in the concrete

The basic rule in relation to concrete is that the higher the cement content, the greater the hardness and strength if all the other factors are the same. Concrete for housing construction is normally provided at N20 grade of 20MP a compressive strength after 28 days curing. Stronger concretes at N25, N32, N40, N50 can be provided for special projects.

The other critical factor for concrete strength is the amount of water in the concrete. Excessive amounts of water will reduce the strength and durability of the concrete. The correct amount of water in a concrete mix can be measured by a slump test. This is typically used by site engineers to test the water content of the concrete. Good concrete typically has a slump of 80mm but slumps of greater than 120mm are normally associated with poor concrete having a high water content. Specialised concretes which are highly plasticised to enable them to be pumped are also used. These have a high slump but do not cause excessive shrinkage.
Shrinkage of Concrete

As concrete loses water (cures) it shrinks which can lead to cracking. The higher the water content of the concrete the greater the shrinkage takes places. The shrinkage factor varies depending on the climatic conditions but the shrinkage of good quality concrete is about $8 \times 10^{-4}$ metre per metre of concrete length.

This means for a 20 metre length of concrete you could expect shrinkage approaching 20mm. Hence if the concrete was restrained on each end it would result in cracks as shown below:

Fortunately, the use of steel reinforcing in the concrete overcomes this problem.

Strength of Concrete

As stated previously, concrete is extremely hard but brittle. Concrete with no reinforcing has a high compressive strength.

However concrete with no reinforcing has a much lower tensile strength.

Hence if concrete has a tensile force applied to it, it would be likely to crack and fail. This concern is overcome by the use of steel reinforcing in the concrete. Steel has about the same coefficients of expansion and compressive strength as concrete making it ideal to be contained in a concrete matrix.

The advantage of steel over concrete is that it has much higher tensile strength. Steel reinforcing in concrete gives the concrete tremendous increase in tensile strength. This is why concrete can be used in bridges and high-rise buildings.
When concrete cures with steel reinforcing inside, it does not usually show shrinkage cracks because the steel keeps the concrete from shrinking – it essentially pulls the concrete out. When the concrete is cured there is only a small amount of stress remaining in the concrete.

**Correct Steel Reinforcing in Concrete**

It is extremely important the correct amount of steel reinforcing is placed in concrete. Too little steel or incorrect placement can lead to concrete shrinkage cracking or flexional cracking.

The greatest factor is determining the thickness of concrete and the amount of steel reinforcing in housing is the degree of reactivity of the soil. The soil classification is broken down into these groups:

<table>
<thead>
<tr>
<th>Site classifications based on soil reactivity</th>
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<tbody>
<tr>
<td><strong>Class A</strong></td>
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<tr>
<td><strong>Class S</strong></td>
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<tr>
<td><strong>Class M</strong></td>
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<tr>
<td><strong>Class H1</strong></td>
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<tr>
<td><strong>Class H2</strong></td>
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<tr>
<td><strong>Class E</strong></td>
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<tr>
<td><strong>Class P</strong></td>
</tr>
</tbody>
</table>

The reactivity of the soil can be measured by laboratory trials. Site engineers and architects may measure the reactivity of the soil before designing the structure.

Clay soils are normally considered highly reactive because they change size dramatically depending on the water content of the soil. The water content of the soil may change significantly depending of seasonal changes, floods or even the positioning of trees. Large trees can suck all the moisture out of a soil and cause it to collapse or shrink.

The more highly reactive a soil usually the thicker the concrete and the more steel reinforcing is required. Also the more rigid a structure on the top of the slab (double masonry wall) the more thickness and reinforcing is required. Reinforcing that goes into the footing is normally represented by the symbol TM – for example 3012TM. A footing needs to be stiffened so that the walls on top of it do not crack.
Steel reinforcing in the slab is normally represented by the prefix F – for example F82 which means steel reinforcing using 8mm steel rods welded in a square mesh with 200mm centres.

The correct selection of either trench mesh, slab mesh and concrete thickness is extremely important and the minimum standard should be that in the relevant Australian Standards mentioned above. Acceptance of a lower standard should be considered a serious deviation of what is acceptable. The minimum level of reinforcing should be F62 for Class A sites, F82 for Class H sites and F92 for Class E or P.

**Positioning of Reinforcing**

Positing of the reinforcing is probably more important than the amount of steel. Both steel reinforcing in the trenches (footings) and the slab is important.

Correct position of reinforcing in the trench can be achieved by a number of ways. The reinforcing can be suspended from the tip of the trench with ties or the use of bar chairs at the bottom of the trench. Correct position of reinforcing mesh in the slab is usually achieved by using bar chairs or concrete blocks.

The correct positioning of reinforcing in the slab is in the top half of the concrete with at least 30mm of concrete coverage over the steel.

![Diagram](image)

The reinforcing mesh should always overlap other sheets as shown below: The slab reinforcing mesh should extend over the trench mesh where possible.

![Diagram](image)

The slab reinforcing mesh should extend over the trench mesh where possible.
Extra Reinforcing

Some slab designs lead to extra stress that can result in cracking. By remembering that concrete shrinks longitudinally one can determine where slabs will crack due to shrinkage.

Re-entrant corners or internal corners will lead to shrinkage cracking unless extra reinforcing is used. Some examples are given here:

This problem of cracking can be easily overcome by using extra reinforcing across the direction of the cracking. The extra reinforcing will pull the slabs together preventing the cracking. An example is given below:

Very few project builders require this extra reinforcing which results in shrinkage cracking. In highly reactive soils it is even more important that the correct amount and positioning of steel reinforcing occurs.
Problems with Poor Concrete in Wet Areas

In many parts of Australia wet areas of houses are stepped down to allow ceramic tiles to be placed to the same height as the rest of the floor.

This set down can result in one area that is susceptible to floor cracking due to both shrinkage and flexional stresses. Poor concrete may end up in the wet area due to it being the last part of the concrete being placed. At this stage the concrete may already be curing, excess bleed water may run into this area, there is insufficient concrete available and it may also have re-entrant corners.

Builders not following the Australian Standard should be made aware that either a full installation is required or that no warranty can be issued. Wet areas are of great concern because pipes and moisture in this area attract termites. Termite attack around wet areas is typical.
Evidence of Slab Cracking

In most parts of Australia the extent of significant slab cracking due to shrinkage or flexion is minimal. Most shrinkage cracks are 0.3mm or less. It is believed cracks greater than 1.00mm are required to enable termite access.

Many shrinkage cracks are much larger at the top of the slab than further down. This situation is due to a range of reasons including:

- Shrinkage greater at the top
- Damage to the crack at the top making it wider
- Reinforcing lower down stops or tapers the width of the crack

Flexional cracking due to either upwards or downwards movement produces only a hairline crack at the stress point.

![Diagram of a slab showing evidence of shrinkage cracking and heaving](image)

Such cracks have been verified by taking a profile of the crack using a diamond saw. One slab in South Australia that underwent heaving had a crack of 4mm at the top but only a hairline crack below the level of the reinforcing.
Termite Access Through Cracks

The only evidence that can be found of termites entering building via a crack has been through construction or control joints.

Construction joints for example are:

Control joints for example are:

The entry of termites through construction or control joints is extremely common and accounts for the vast majority of termite attacks in Australia.
Retaining Walls and Termite Access

Another significant entry point of termites is through imperfections in retaining walls. Termites are attracted to retaining walls because of moisture build-up and the more loose soil.

Retaining walls of houses are built in many different ways and many different materials. Usually the quality of the mortar joints is not high because the wall is normally rendered on the inside. Once termites enter the retaining wall they may be able to gain access to the rest of the building without detection.

It is important retaining walls are protected with Biofilm installed over all the area of the retaining wall externally. An example is given below:

Only rendering the wall may not be sufficient due to delamination or cracking. Only accredited installers may apply Biofilm.

Further Reading:

More detailed information on concrete and design can be found in the following publications:

1. Recommended Practice – Curing of Concrete
   Concrete Institute of Australia (1991)
2. Construction Note CN5
   Concrete – Placement and Finishing.
   Cement & Concrete Association of Australia (1982)
3. 10 Steps to Build a Reinforced Concrete Slab-On-Ground
   Steel Reinforcement Institute of Australia (1992)
   Part 1: Construction
5. AS 2870.2 (1990) Residential slabs and footings
   Part 2: Guide to design by engineering principles
6. AS 3600 (1988) Concrete structures
Session Three

Installing Biofilm

Objective: Develop the essential skills and knowledge necessary to effectively install Biofilm to specification.
Biofilm Termite Barrier System

The Biofilm system has been designed with one concern in mind, and that is to provide measures to reduce the risks of undetected subterranean termite ingress into buildings.

The Biofilm training manual provides installation measures to deter termite ingress arising from concealed entry points into the building. The system also relies on a combination of partial measures combined with maintaining perimeter inspection zones so that the evidence of termite workings is forced out into the open where their presence may be detected more readily.

The following drawings and instructions when read in conjunction with the relevant Codes and Standards will provide a comprehensive guide to the correct installation and maintenance of the Biofilm Termite Barrier System.

NB: "A range of options is provided so that barriers may be used either singly, or in combination to provide an integrated termite barrier system".
Biofilm Termite Barrier System

Method of Application

The components that go towards making up a full Biofilm protection treatment for buildings is as follows:

(a) Full under floor treatment
(b) Suspended floors
(c) Step down slabs
(d) Paths and additions
(e) Retaining walls
(f) Construction joints and saw cuts
(g) External Perimeter Treatment
(h) Cyclone tie-down rods
(i) External Cladding
(j) Zero boundary
(k) Pipes and service penetrations
Full Under Floor Treatment

Biofilm can be utilized to provide full under floor protection to the property by creating a full and continuous barrier when installed to specifications.

- Biofilm is installed following the concrete pouring of all internal and edge beams.
- Biofilm is to be laid as a continuous barrier beneath the slab, with care taken to cover the top of all internal and edge beams.
- Biofilm is required to be adhered to the interior wall of the formwork using pins and/or spray adhesive. Alternatively Biofilm is to extend past the interior wall of the formwork.
- When laying Biofilm it is essential to allow enough loose sheeting to accommodate concrete pour.
- A minimum of 200mm of Biofilm is to extend beyond the perimeter of the slab allowing for any slab rebates, exposed slab edges, or similar perimeter attachments.
- Biofilm is to be laid on top of bedding sand and up any vertical faces.

NOTES

When Biofilm is employed between a joint of two separate concrete slabs (cold joint), the Biofilm sheet is to be folded over on itself with the fold at the top of the joint between the two slabs.

The sheet is to be adhered to the face of the original slab using pins and/or an approved adhesive, ensuring the vertical section is in contact with the original slab a minimum of 100mm in depth.

The Biofilm is to extend a minimum of 300mm under the new slab horizontally.
Full Under Slab Monolithic Slab

Full Under Slab Tied Monolithic Slab

Stiffened Slab with Edge Beam (Monolithic)

Waffle Pod Full Under Slab
Full Under Slab Infill Non-Monolithic  

Suspended Floors

- When installing, Biofilm is to be allowed an overhang of 40mm to adhere to AS3660.1
- To accommodate an existing pin or thread in a stump, a small hole can be made in the Biofilm to allow it to be forced over the pin and installed.
- Only an approved adhesive should be utilized to attach the Biofilm to the stump, no nails/pins etc.
- Biofilm is able to be installed between the stump and traditional aluminium or tin termite shield if so required.

Step Down Slabs
Garage Step Down block construction

Garage Step Down block construction (Var. 1)

Garage Step Down Block construction (Var. 2)

Paths and Additions

Wall Sheeting to Garage

Z/Starters/Reinforcing Bars

Biofilm

Z/Starters/Reinforcing Bars
For existing slabs/masonry to new concrete joints (*cold joints*).

- Ensure existing concrete is clean and the surface is even prior to installing.
- Adhere one edge of Biofilm to the vertical edge of the existing surface with an approved adhesive with the cut facing downwards so a fold is made at the top of the joint. Ensure a minimum of 20mm is allowed over the upper edge of the new slab.
- Adhere all joints with an approved adhesive.
- Ensure the Biofilm sheeting runs continuously along the footing and extends a minimum of 300mm horizontally beneath the new slab.

**Retaining Walls**

Biofilm is an effective termite protection for utilization in construction of retaining walls. Any size of Biofilm can be used for such installation, provided that all joins are installed to specification with an approved adhesive and cloth tape.

- Biofilm is installed following the builders’ waterproof material’s installation to the rear of the wall.
- Secure the Biofilm to the top of the wall using contact adhesive/pins.
- Ensure all joins of Biofilm have minimum of 200mm overlap and that the upper sheet falls on top of the lower.
- Biofilm is to be installed to the base of the retaining wall, as well as across the footing a minimum of 200mm to ensure the base course mortar joint is covered, before being secured to the concrete/brickwork.
- Apply the Biofilm to the bottom of the wall and work upwards to ensure any water is voided outside the structure.
- Ensure the top section of Biofilm is adhered to the top of the wall with an approved adhesive and/or pins.
Retaining Wall Biofilm Installation
Retaining Wall Biofilm Installation (Var. 2)

Retaining Wall Biofilm Installation (Var. 3)
**Construction Joints & Saw cuts**

- A minimum of 300mm wide strip of Biofilm is to be installed directly under the joint by using an approved adhesive to attach to the moisture membrane.
- All vertical joints are to be protected by ensuring the Biofilm is folded over on itself with the fold at the top of the joint between the two joining slabs.
External Perimeter Treatment

Biofilm has been assessed by the Australian Pesticides and Veterinarian Medicines Authority to be an effective Termite Barrier when installed to specifications. Any tears, rips, or holes in the Biofilm sheeting must be repaired as per this manual.
Biofilm Perimeter Barrier with Cavity Detail – Render.

N.B – Only Rendered Bricks are required to have a strike joint. Bagged Bricks do not require a strike joint to be present.

Biofilm Perimeter Barrier with Cavity Detail – Non-Monolithic Infill

Option A

Option B

Biofilm Barrier at Slab on Ground with No cavity with separate footing
**Cyclone Tie-down Rods**

- Ensure all loose/rough concrete along the perimeter is removed, paying particular attention to the area around the tie-down rod.

- Lay out the Biofilm on top of the slab along the intended installation area.

- Mark out each of the tie-down rods locations on the Biofilm.

- Measure the distance between the outer edge of the block wall and the rod and mark out on corresponding Biofilm.

- Cut a hole in the required area of the Biofilm sheeting at the marks using an 8mm wad cutter.

- From the inner edge of the sheeting, use scissors to slice to the holes.

- Starting from the external side edge of the block wall, slide the Biofilm sheeting into place.

- Use the 8mm wad cutter to create a hole in the centre of 200mm x 150mm strips of Biofilm to create patches.

- Slide the patch over the tie-down rod and flush to the installed Biofilm.

- Use cloth tape to secure all edges of the patch to the installed Biofilm.
External Cladding

When using Biofilm in conjunction with cladding, ensure there is pressure between the cladding and the slab of the house, and/or adequately adhered to the slab with an approved adhesive/pins.
Zero Boundary – Single Leaf Masonry Wall

When using Biofilm to protect a single leaf, zero boundary masonry wall install to the specifications as shown below in the diagram provided.
Penetrations

When using Biofilm to protect slab penetrations, it is imperative that the biofilm be in contact with the penetration (pipe or service) a minimum of 20mm and have an annular flange with a minimum width of 15mm on all sides. There is to be no gap larger than 0.4mm between the Biofilm and the penetration at any point. More details can be found in AS3660.1:2014 Section 5.3.6 Concrete Slab Penetrations.

- Cut a section of Biofilm to wrap around penetration with a minimum of 20mm overlap.
- Cut a patch of Biofilm large enough to slide over the Penetration with a minimum of 20mm flange on all sides.
- Fold the wrap section in half and wrap around penetration with the fold at the top. Secure with a zip tie.
- Fold the patch in half, then in quarters, then diagonally in eighths to create a point.
- Make a cut in the Biofilm so that when you unfold the patch you can slide over the penetration to sit snugly on the wrap.
- Secure with a second zip tie.
- Ensure an annular flange of 20mm is on all sides of the biofilm and that there are no gaps greater than 0.04mm.