Installation Guidelines for the Basaltic Termite Barrier: A Particle Barrier to Formosan Subterranean Termites (Isoptera: Rhinotermitidae)

by

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ABSTRACT

The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, is the most economically important insect pest in Hawaii, and an increasing problem in North America. For many decades, the principle eans of preventing infestations by subterranean termites has been rough application of soil insecticides. More recently, however, physi-.l barriers have been developed as substitutes for chemical applica-ᴗons. The first particle barrier to be developed commercially was the Basaltic termite barrier (BTB), which was commercialized in Hawaii in 1987. However, a number of factors reviewed in this article have kept the popularity of BTB as a substitute for termiticides from reaching its full potential. The lack of understanding of installation requirements for this barrier on the part of architects and building contractors has resulted in several failures, unrelated to the basic efficacy of the material. Our subsequent evaluations of these faulty installations identified key problem areas and led us to develop installation guidelines for termite-resistant particle barriers in both pre-construction and post-construction applications.

INTRODUCTION

The cost for prevention, remedial treatments, and repair costs for the Formosan subterranean termite, *Coptotermes formosanus* Shiraki, have been estimated at ca. US $100 million annually in Hawaii (Tamashiro *et al.* 1990b). The problems associated with this economically important insect pest have escalated with the shift towards urbanization as residential developments arise in areas formally used for plantation agriculture of pineapple and sugarcane.

Otagaki *et al.* (1970) reported that residents of Hawaii use more pesticides in and around the home than residents in other urban areas of the United States. A major contribution to this pattern has been the peated use of soil treatments to prevent penetration by Formosan ıbterranean termites. Unfortunately, concrete foundation walls and concrete slabs of the type normally found in cost-conscious construction are rarely sufficient alone to keep termites from reaching structural wood (Grace 1999). Although use of cyclodiene insecticides in Hawaii ceased in 1998, the reduced longevity of replacement termiticides (Tamashiro *et al.* 1990a, Grace *et al.* 1993) has resulted in an increase in the frequency of subterranean treatment applications (Tamashiro *et al.* 1990b). Other factors contributing to pesticide use have been shorter treatment warranties offered by the pest control industry, and repeated chemical applications within the warranty period due to inadequate initial treatment and/or termiticide failure. Continued and increased pesticide use escalates costs to homeowners and increases the potential exposure of residents and the fragile Hawaiian environment to deleterious effects. Of particular concern is the protection of the water supply, since agricultural pesticide contamination has been reported and the termiticide chlordane has been found in trace levels in wells.

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Particle barriers have been tested and are gaining in popularity worldwide as physical alternatives to insecticide barriers to prevent subterranean termite penetration and attack on structures. Although diatomaceous earth did not prove too effective (Grace & Yamamoto 1993), crushed basalt (Tamashiro *et al.* 1987a, 1987b, 1990b, 1991), granite (Smith & Rust 1990, French & Ahmed 1993, French 1991, 1994; Ahmed & French 1996), quartz and coral sand (Su *et al.* 1991), silica sand (Ebeling & Pence 1957, Ebeling & Forbes 1988), brick, concrete, limestone and natural sand (Miles 1997a, 1997b), and even glass shards (Pallaske & Igarashi 1991) screened to specific particle sizes have proven to be effective in preventing termite penetration, although the effective particle size ranges differ from one termite species to another (Su & Scheffrahn 1992).

DEVELOPMENT OF THE BASALTIC TERMITE BARRIER

The development of the Basaltic termite barrier (BTB) as a permanent physical barrier for use in Hawaii was the result of extensive laboratory and field tests with the Formosan subterranean termite (Tamashiro *et al.* 1987a, 1987b, 1990b, 1991). Positive laboratory and field research results and the commercial potential of BTB led to its patent by the Office of Technology Transfer and Economic Development at the University of Hawaii at Manoa. Subsequently, this technology also led to development of a similar crushed granite product that is marketed in Australia as Granitgard (Granitgard Pty. Ltd., Victoria).

Ameron Hawaii (formerly known as Ameron HC&D) first commercialized BTB on Oahu, Hawaii, in 1987; and the product was adopted into the Uniform Building Code of the City and County of Honolulu in 1989 as an alternative to chemical preconstruction soil treatments. BTB has been primarily available on the island of Oahu, where it is produced, due to the special equipment requirements for screening the crushed rock to the proper size distribution. It is shipped by Ameron Hawaii to the other Hawaiian islands and available there either from Ameron or a local distributor, but shipping costs are relatively high. Use of BTB on the island of Hawaii is expected to increase, however, since it is now also manufactured on this island. This physical barrier is primarily used as fill beneath concrete slab foundations and as backfill for retaining walls during new construction, and around the perimeter of the concrete undation slab after it has been poured. A minimum four-inch layer of [B is recommended for these applications. BTB can also be used to fill e interior hollow voids in hollow tile (concrete masonry unit) construc-)n. Although the primary use of BTB is in new construction, post-nstruction uses are being developed.

ACCEPTANCE AND IMPLEMENTATION

Although it is the most successful patent held by the University of Hawaii, BTB has not been as widely accepted as was hoped by consumers, architects, and contractors in Hawaii as a substitute for pre-construction chemical treatment. Reasons for this reduced acceptance include consumer unawareness of the product, a slight initial cost advantage for insecticide treatments, unwillingness of the pest control industry to accept and become involved in implementing this technology, a poor understanding of installation requirements by architects and contractors, and the absence of a BTB performance warranty program.

It can be difficult and labor intensive to install BTB since the layer beneath the concrete slab must be consistently thick, unbroken and uncontaminated in order to be effective. We have observed several BTB installations in Hawaii that failed to prevent Formosan subterranean termite infestations in structures with either monolithic or floating concrete slab foundations. Lewis *et ai.* (1996) also observed occasional failures when a sand barrier was used to prevent *Reticulitermes* spp. infestation in California. Investigation of the structures where failures were observed in Hawaii by coring through concrete slabs to evaluate ie BTB barrier revealed two common installation faults: contamina-on of the BTB with material from the surrounding area (*eg.* soil, gravel, tc.) and/or uncleaned equipment, and failure to maintain a minimum)ur-inch BTB layer beneath the slab.

Another difficulty that arises during installation when BTB is used as fill material under a monolithic concrete slab is the resulting angle

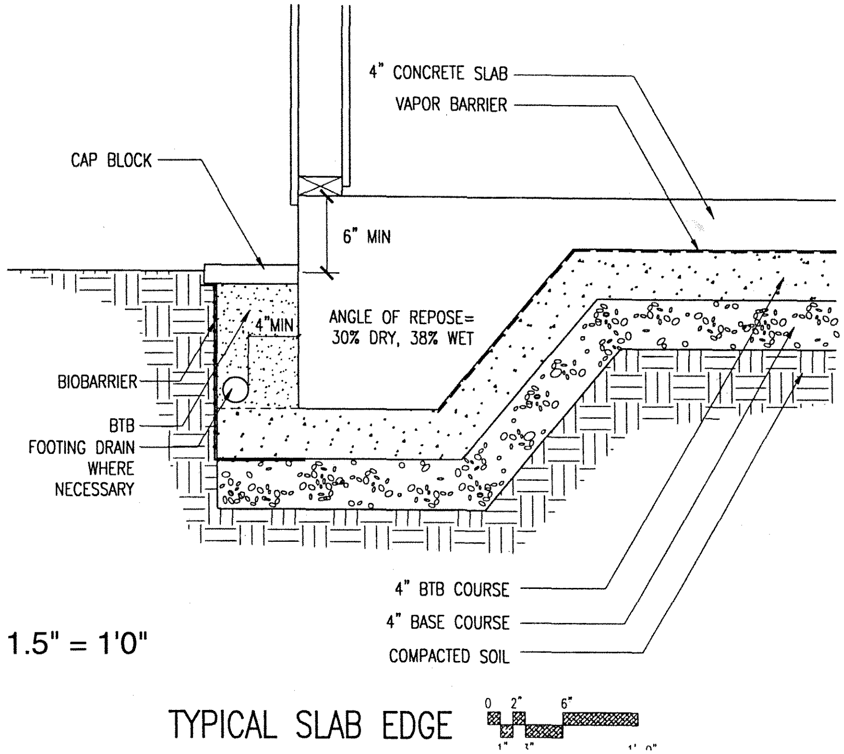
of repose at the concrete footing. The construction industry standard is 45°, but the fluid-like nature of BTB results in a 30° angle of repose when it is dry and 38° when it is wet (Fig. 1-4). This condition increases the amount of concrete needed and thus the costs of construction. Further concerns include displacement of the BTB caused by the impact of concrete when it is poured and when construction workers walk on the material, and contamination of BTB when removing concrete form stakes.

A Cooperative Extension project was developed in the Department of Entomology at the University of Hawaii at Manoa to help resolve these issues and improve BTB installation practices in Hawaii. Objectives included the development of pre- and post-construction installation and use specifications for BTB in Hawaii; instructional seminars for developers, architects and building industries throughout the State on implementation of the specifications; and incorporation of the specifications into the Uniform Building Code for all counties in Hawaii. A 16-minute videotape was produced (Yates 1997) for use in these seminars, and was distributed to libraries throughout the state, to illustrate acceptable installation procedures for BTB beneath and around concrete slabs, and when the product is used as backfill behind hollow tile retaining walls. We provide these guidelines here in order to further encourage proper use of the Basaltic termite barrier, and as an aid to entomologists, architects, and contractors in other regions who are considering the use of particle barriers to prevent termite infestation.

INSTALLATION GUIDELINES FOR NEW CONSTRUCTION

Concrete Slabs. Initial preparation of the soil and the base course (Fig. 1) upon which the Basaltic termite barrier will be placed is critical. The base course must be level, compacted to specifications, and free of roots and rocks to insure a uniform four inch layer of BTB. Proper compaction of soil beneath the base course either before or after the concrete forms are in place is crucial to provide a reliable and stable base course. Improper preparation can result in soil shrinkage or expansion under the concrete slab and a void between the BTB layer and the bottom surface of the slab. This condition will allow Formosan subterranean termites to freely forage throughout this area. If the expansive property of the soil exceeds the building specifications, it should be removed and replaced with a proper soil type. This precaution will also minimize concrete cracks.

A method to limit the flow of BTB into the footing or to increase the angle of repose when installed under monolithic slabs incorporates Stay-Form™ (Alabama Metal Industries Corporation) near the footing



ig. 1. Typical monolithic concrete slab edge showing the BTB detail, the termination point of the apor barrier, and the use of BioBarrier.

ıs a BTB barrier (Fig. 5), a thin metal form. The Stay-Form is vertically suspended within the slab area with steel stakes placed approximately one foot from the perimeter concrete forms, and at a height such that he top edge of the Stay-Form is at the level of the bottom of the concrete slab that is four inches above the base course and four inches below the op of the concrete forms. This will ensure at least four-inch BTB and concrete slab thickness. The horizontal distance between the Stay-Form and concrete forms will determine the thickness and strength of he concrete footing, which should be specified by a structural engineer. The lower edge of the Stay-Form is held four inches above the base course to allow BTB to flow into the footing area, thereby creating a continuous four-inch layer of BTB under the footing and under the concrete slab. The necessary height, and therefore, thickness of the planned BTB layer under the concrete slab can be ascertained with a aut string that represents the top of the concrete forms. A distance of

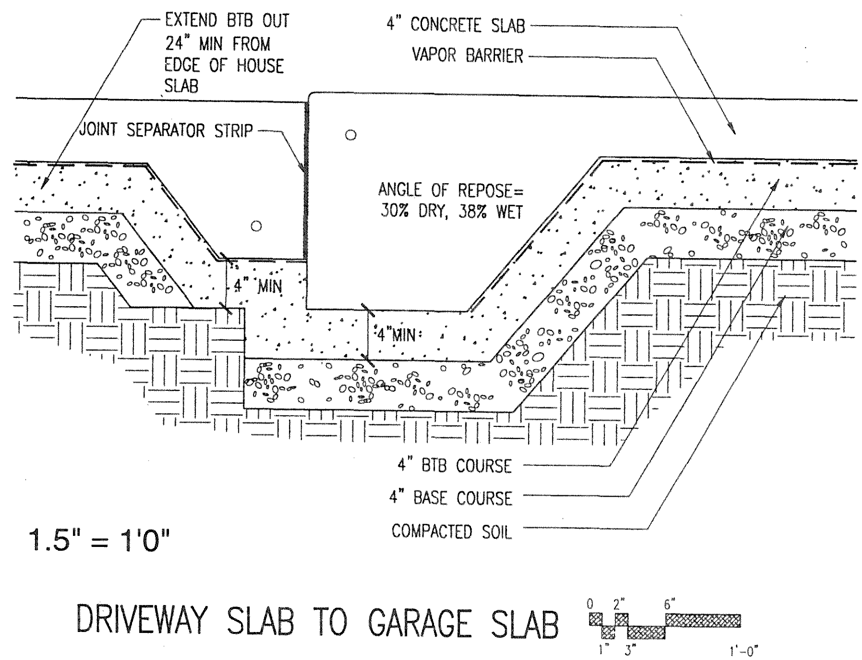
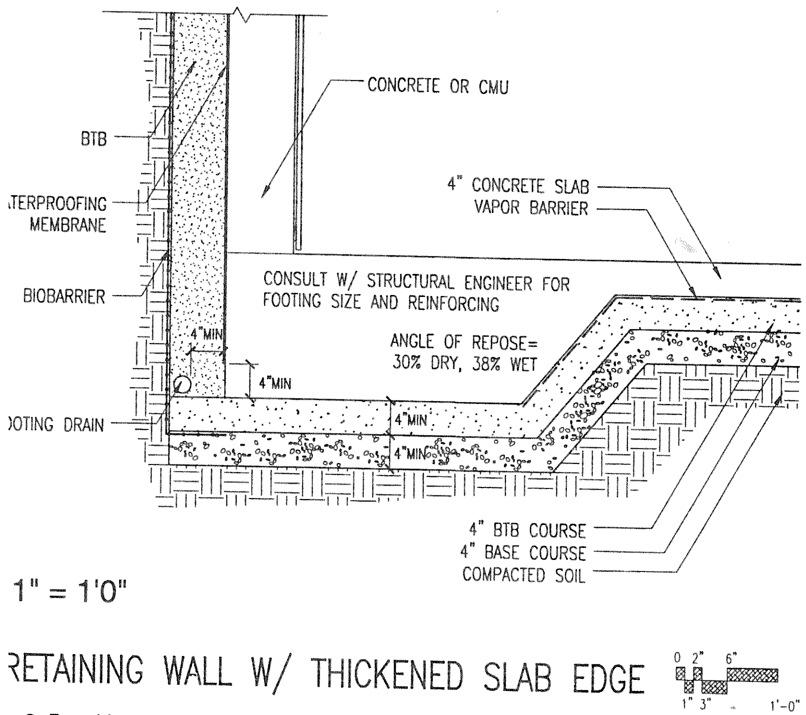


Fig. 2. Basaltic termite barrier installed beneath a concrete driveway and garage slab.

four inches between the string and the top of the BTB layer will ensure that the BTB and the concrete slab will have a minimum four inch thickness. This measurement should be monitored throughout the BTB installation.

After the concrete forms, plumbing, conduits, Stay-Form and anything else that will penetrate the concrete slab have been installed, BTB installation can commence by spreading and leveling the material throughout the slab area. However, BTB is most vulnerable to contamination by soil or construction debris at this stage. Although manual installation can be labor-intensive with large areas, it is preferred over the use of machinery to prevent contamination, and it is equally important that all hand tools be cleaned before use. When BTB is installed as a four inch layer, it is self compacting; but greater thickness will require compaction. For example, BTB must be compacted in one foot lifts when used as a backfill for retaining walls.

When the BTB installation is complete all metal plumbing and electrical conduit pipes that will penetrate the concrete slab must be wrapped with specified tape to prevent corrosion. The taped portion of pipes should begin at the top surface of the BTB layer and extend



ı. 3. Basaltic termite barrier installed beneath a thickened concrete slab edge and as backfill a retaining wall.

ɔward for a total wrap of approximately six inches.

The final preparation step prior to pouring concrete is the installation plastic sheeting over the BTB layer. The plastic primarily serves as vapor barrier. However, it also reduces the disturbance of the BTB ɪen masons walk over the material while placing reinforcing steel and ɪuring the concrete, and when falling concrete impacts the termite ɪrrier. It is important that the edges of the plastic sheet stop at the side edge of the perimeter footing and not extend beneath the footing beyond the concrete forms, and should preferably be limited to the ay-Form (Fig. 5). If Stay-Form is not used, then the vapor barrier ould be limited to the base of the footing (Fig. 1-4). If the plastic sheet extended beyond the concrete form, termites may be able to bypass e BTB layer by foraging between the plastic sheet and lower concrete ıb surface.

Whether Stay-Form is used or not concrete should first be introduced ıııto the footing areas until the concrete overflows onto the slab areas.

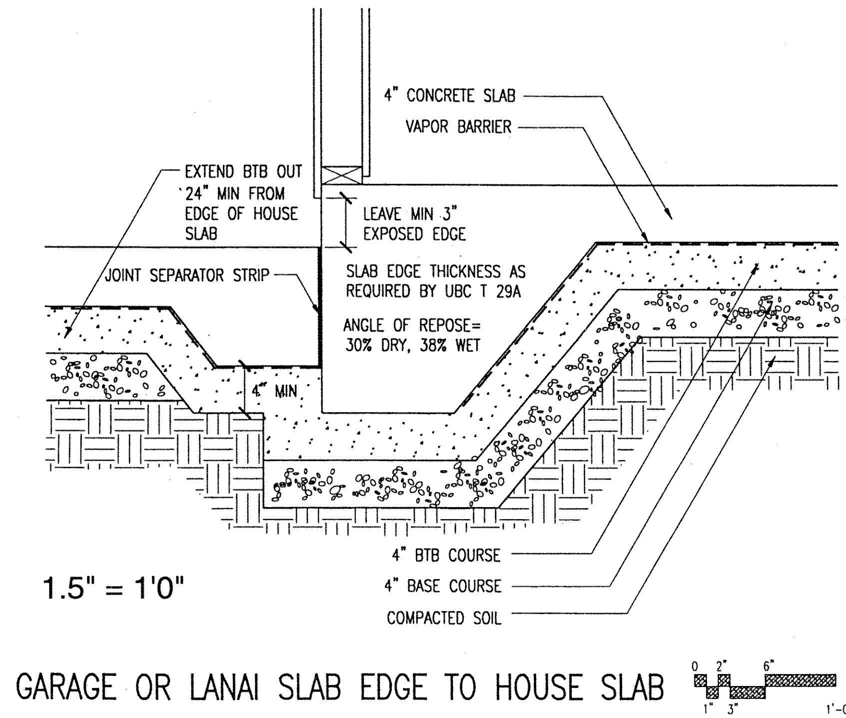
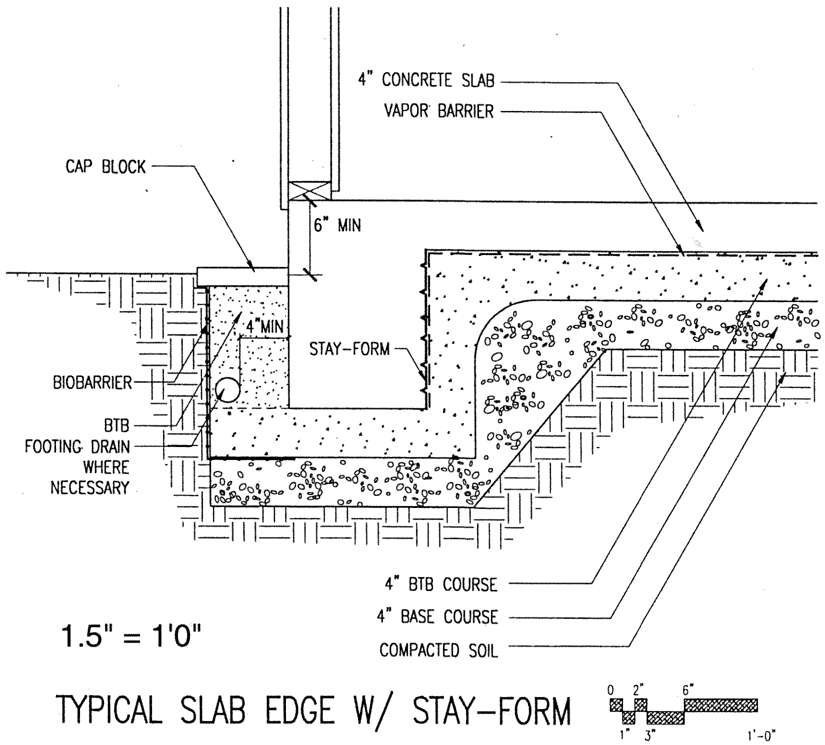


Fig. 4. Basaltic termite barrier installed beneath a garage or lanai (patio) slab edge and main structural slab.

The concrete overflow will act as an additional cushion to protect the BTB when concrete is poured directly onto the slab areas. The BTB must be backfilled against the concrete slab and brought up to grade level after the concrete has cured and the concrete forms have been removed.

Hollow Tile Retaining Walls and Stem Wall Foundations. A significant number of homes, particularly on the island of Oahu, are built on the slopes of hills or ridges. Soil is excavated to create a flat foundation area, and the resulting soil embankments are commonly retained by built-up hollow tile block walls and sometimes by poured-in-place concrete walls. Typically, a concrete slab is poured within the retaining walls and these units serve as the principle foundation for the structure (Fig. 6). A variation of this design is created with stem-wall post-on-pier foundations (Fig. 7) and when concrete slabs are supported by retaining walls (Fig. 8).

These retaining walls are normally waterproofed and provided with protection board to protect the waterproofing layer during the backfill-



ig. 5. Monolithic concrete slab edge with Stay-Form installed to increase the BTB angle of repose.

ng process. Soil is frequently used as backfill material. This condition ıas resulted in many Formosan subterranean termite infestations, ›articularly when the wall was constructed with hollow tile blocks. Chemical treatment of backfill during the backfilling process is rarely lone properly and offers only temporary protection, and since these valls are usually 8 to 10 feet in height it is not possible to thoroughly reat the soil from grade level to the footing area once backfilling has ›een completed.

One of the principle uses of BTB is to apply it as backfill behind etaining walls in place of soil (Fig. 6-8). However, as with concrete ;labs, the preparation of the area to be backfilled is critical. All debris ncluding rocks, roots, and excess mortar used to construct the hollow ›lock wall must be removed. It is also pertinent that the mortared joints ›f the block wall and the concrete footing surfaces be trowelled to a ;mooth finish (flush joint). If a perforated pipe drain is to be provided at the base of the wall, the drain must be positioned so that it can be

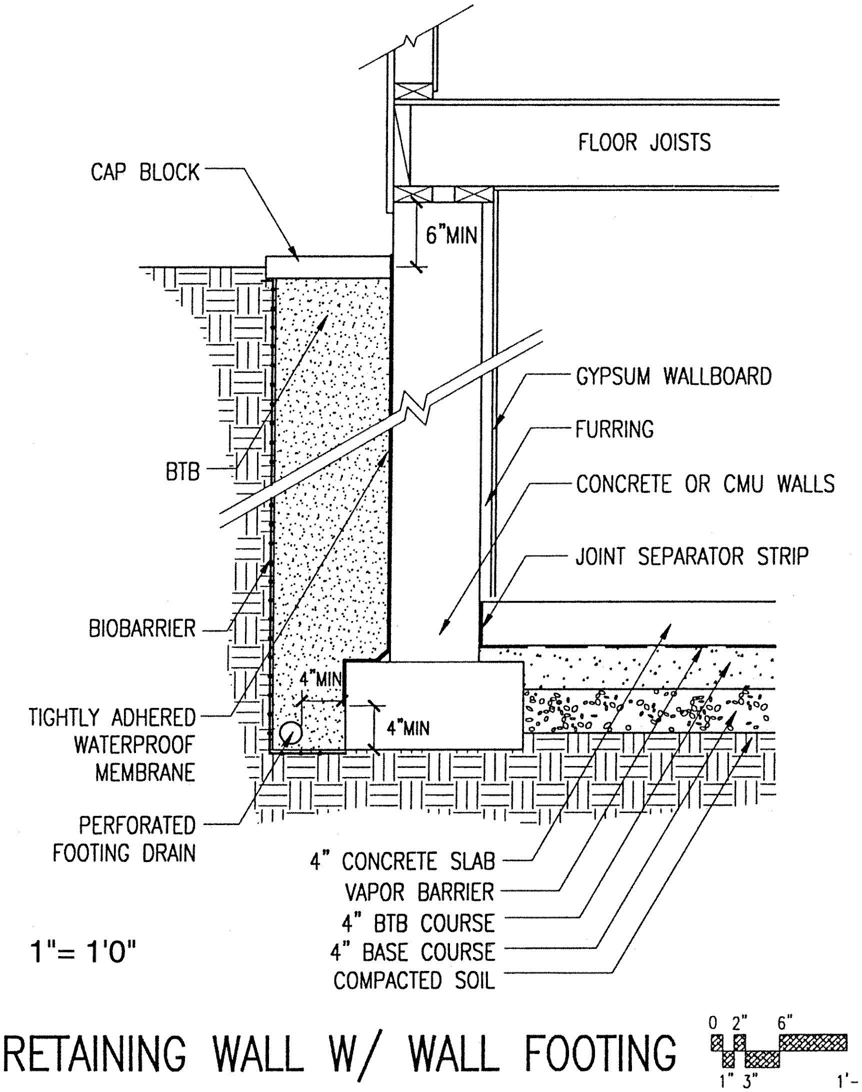
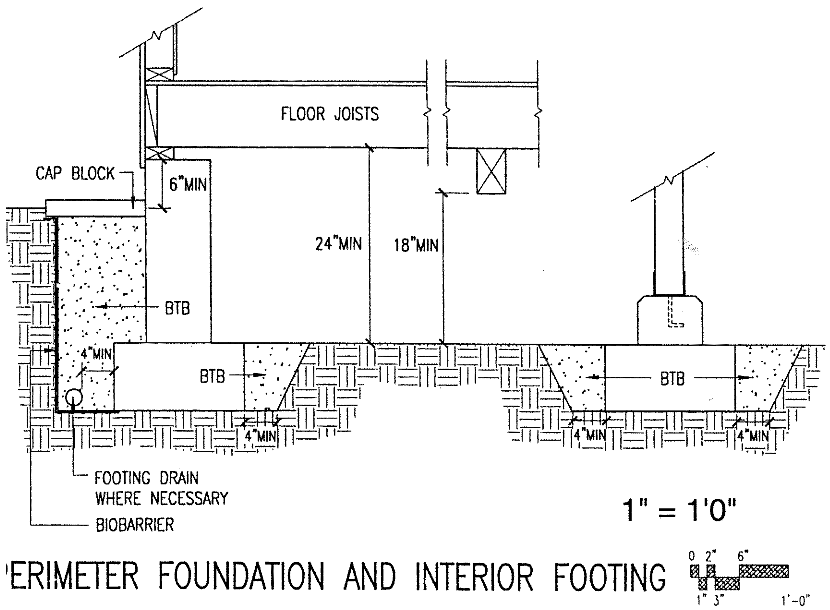


Fig. 6. Basaltic termite barrier installed beneath a floating concrete slab and as backfill for a retaining wall.

totally enveloped in BTB and with at least four inches of BTB between the drain and edge of the footing. It is also important to cover the soil embankment with BioBarrier™ (Reemay, Inc.) whenever BTB is applied adjacent to soil. This will prevent root growth into the BTB that will compromise its efficacy, and the BioBarrier will also prevent contami-



ȝ. 7. Basaltic termite barrier installed as backfill for a stem foundation wall and around post-on-
ɜr foundation blocks.

ation by soil falling onto the BTB during its installation. Once these
rovisions are complete, the BTB backfilling can be initiated using
ther of two methods.

The first method uses BTB as a total backfill to fill the void between
ıe block wall and excavation cut. BTB is introduced into this area in
ıe-foot lifts and each lift must be compacted. This process is repeated
ntil the BTB backfill is raised to the existing grade.

The second method incorporates BTB as a partial backfill. However,
ıis process is labor intensive and the cost for this labor may exceed the
ɔst for the additional BTB that would be used as a total backfill. After
ıe area has been prepared as described above, a temporary partition
needed to separate the BTB backfill from the soil backfill. The
artition can be plywood, but it must be removed after each BTB/soil
t is completed. Non-cellulosic partition material (*e.g.* corrugated sheet
ıetal or fiberglass roofing) can be left as part of the backfill. Before
ıitiating the BTB/soil backfill, BTB should first be added to the footing
rea to a height that is at least one foot above the top surface of the
ɔncrete footing. After this layer is compacted, backfilling can be
ɔmpleted with BTB and soil. With the partition positioned at least four
inches (preferably 8-12 inches) from the block wall, add BTB between

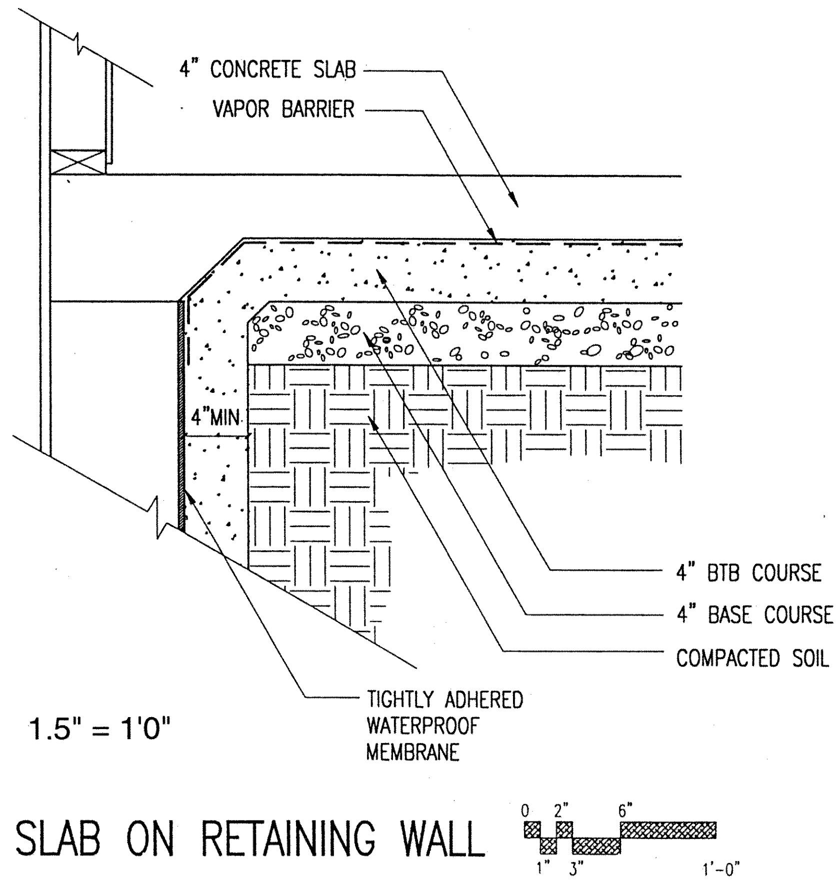
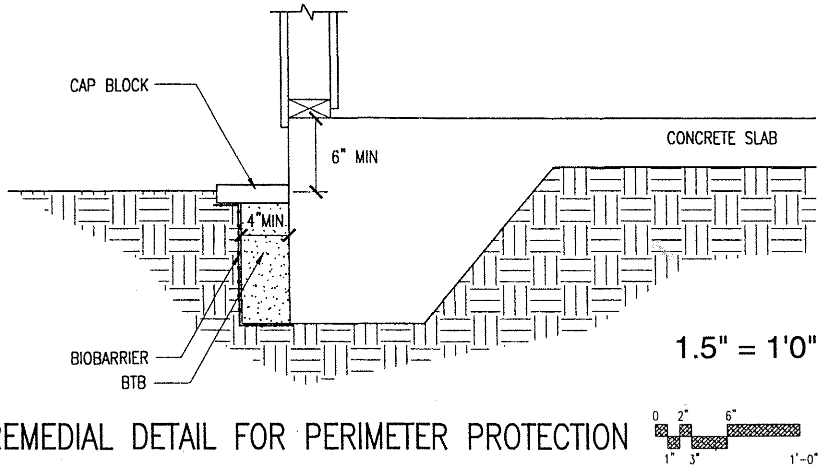


Fig. 8. Basaltic termite barrier detail for concrete slabs that are supported by retaining walls.

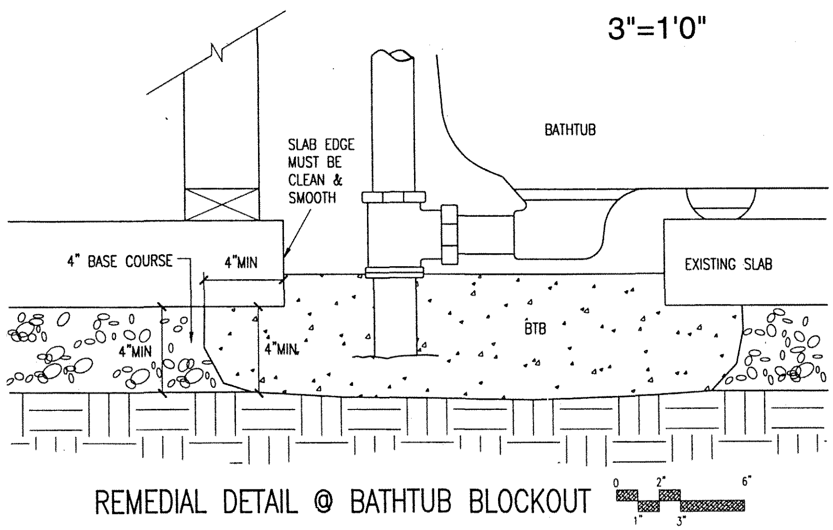
the partition and block wall, followed by adding soil between the partition and cut hillside. When each substrate has been compacted, the partition should be removed if it is wood, and this process continued until the entire area has been backfilled to the existing grade.

POST-CONSTRUCTION INSTALLATION

Backfill Around Concrete Slab Perimeter. BTB can be used to substitute for chemical soil treatment around existing concrete slab perimeters to prevent Formosan subterranean termite infestations. We have supervised a number of installations. However, other provisions are also needed to protect the BTB (Fig. 9) with this type of application.



g. 9. Installation detail for BTB around the perimeter of an existing monolithic concrete slab.



ig. 10. Remedial detail for BTB installation in a bathtub blockout.

Dig a trench that is at least four inches wide and deep around the :ntire perimeter of the concrete slab, when possible. Clean the vertical ace of the concrete slab to remove soil and other debris, and check for rregular concrete surfaces. Grind raised surfaces and/or fill depres- ;ions with a cement/water paste or epoxy. Line the soil portions of the _rench with BioBarrier to prevent root growth into the BTB and fill the trench with BTB to the existing grade height. As a final step, cover the

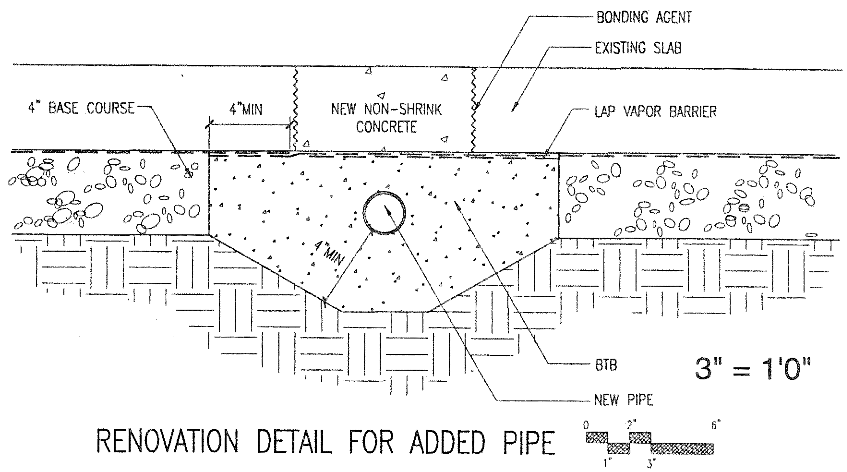


Fig. 11. Basaltic termite barrier detail for pipe renovations beneath concrete slabs.

exposed BTB surface with a poured concrete cap or place hollow tile block caps end-to-end over the BTB. This will prevent soil and/or leaf litter from contaminating the BTB, and it will also prevent cats from using the BTB as litter. It is important to note, however, this installation will not prevent subterranean termites from penetrating cold joints that are created when a patio slab, garage slab and/or perimeter walkway is adjacent to a structural slab.

Bathtub Blockout. Bathtub blockouts (Fig. 10) in concrete slabs that accommodate bathtub drain connections to the sewer system are commonly left open, although this violates a building code in this state. However, with proper preparation of the area, BTB can be introduced into the blockout to act as a barrier to Formosan subterranean termites. All debris including plastic and form material must be removed, and the base course must be excavated to provide at least a four inch layer of BTB that extends at least four inches under the existing concrete slab. As described above, it is critical that the vertical faces of the slab that are in contact with the BTB be clean and smooth.

Plumbing Renovation. Remodeling slab-on-grade homes will often require that new plumbing be placed beneath concrete slabs (Fig. 11). It is advisable with this type of construction that the base course be excavated to provide sufficient room for the pipe to be enveloped by four inches of BTB. This will prevent termites from foraging along the length of the pipe and entering the structure at the point where the pipe penetrates the concrete slab, and it will also prevent termites from penetrating at the cold joints created by the patched concrete slab.

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REFERENCES

hmed, B., & J.R.J. French. 1996. Termite physical barriers: update on retrofitting Granitgard around "mock-up" buildings after four years. International Research Group on Wood Preservation Document Number IRG/WP/96-10140. 6 pp.

beling, W., & C.F. Forbes. 1988. Sand barriers for subterranean termite control. IPM Practitioner 10(5): 1-6.

beling, W., & R.J. Pence. 1957. Relation of particle size to the penetration of subterranean termites through barriers of sand or cinders. Journal of Economic Entomology 50: 690-692.

rench, J.R.J. 1991. Physical barriers and bait toxicants: the Romeo and Juliet of future termite control. International Research Group on Wood Preservation Document Number IRG/WP/1503.

rench, J.R.J., & B. Ahmed. 1993. Termite physical barrier: is retrofitting with Granitgard and option? International Research Group on Wood Preservation Document Number IRG/WP/93-40011.

rench, J.R.J. 1994. Combining physical barriers, bait and dust toxicants in future strategies for subterranean termite control (Isoptera). Sociobiology 24: 77-91.

race, J.K. 1999. Termite penetration of construction elements. Shiroari 115: 18-23 (in Japanese).

race, J.K., and R.T. Yamamoto. 1993. Diatomaceous earth is not a barrier to Formosan subterranean termites. Sociobiology 23: 25-30.

race, J.K., J.R. Yates, & M. Tamashiro. 1993. Testing soil insecticides in paradise. Pest Control 61(7): 60-61.

ewis, V.R., M.I. Haverty, D.S. Carver, & C. Fouche. 1996. Field comparison of sand or insecticide barriers for control of *Reticulitermes spp.* (Isoptera: Rhinotermitidae) infestations in homes in Northern California. Sociobiology 28: 327-335.

Ayles, T.G. 1997a. Penetrability of some Ontario construction aggregates by the Eastern subterranean termite (Isoptera: Rhinotermitidae). Sociobiology 30: 277-288.

Ayles, T.G. 1997b. Comparison of the penetrability of smooth and crushed sand by subterranean termites (Isoptera: Rhinotermitidae). Sociobiology

30: 295-303.

Otagaki, K., A. Bevenue, J. Hylin, A. Evers, W. Hilton, R. Nekomoto, W. Purdy, J. Smith, S. Uehara, P. Royen, H. Young, H. Kimura, & R. Hurov. 1970. Evaluation of the pesticide problem in Hawaii. Report of Pesticide Committee submitted to the Hawaii State Legislature, 1970. 113pp.

Pallaske, M., & A. Igarashi. 1991. Glass splinters as physical barriers: optimized material properties in use with and without insecticidal pretreatment minimizes environmental contaminations. International Research Group on Wood Preservation Document Number IRG/WP/1476.

Smith, J.L., & M.K. Rust. 1990. Tunneling response and mortality of the western subterranean termite (Isoptera: Rhinotermitidae) to soil treated with termiticides. Journal of Economic Entomology 83: 1395-1401.

Su, N.-Y., R.H. Scheffrahn, & P.M. Ban. 1991. Uniform size particle barrier: a physical exclusion device against subterranean termites (Isoptera: Rhinotermitidae). Journal of Economic Entomology 84: 912-916.

Su, N.-Y., & R.H. Scheffrahn. 1992. Penetration of sized-particle barriers by field populations of subterranean termites (Isoptera: Rhinotermitidae). Journal of Economic Entomology 85: 2275-2278.

Tamashiro, M., J. R. Yates, & R. H. Ebesu. 1987a. The Formosan termite: Hawaii's most damaging insect. Hawaii Architect 16(12):12-14, 40.

Tamashiro, M., J.R. Yates, & R.H. Ebesu. 1987b. The Formosan subterranean termite in Hawaii: problems and control. Pp. 15-22 *in:* Biology and control of the Formosan subterranean termite (M. Tamashiro and N.-Y. Su, eds.) HITAHR Res. Ext. Series 083, University of Hawaii, Honolulu.

Tamashiro, M., J.R. Yates, R.H. Ebesu, & R.T. Yamamoto. 1990a. Effectiveness and longevity of termiticides in Hawaii. HITAHR Res. Ext. Series 119, University of Hawaii, Honolulu.

Tamashiro, M., J.R. Yates, R.T. Yamamoto, & R.H. Ebesu. 1990b. The integrated management of the Formosan subterranean termite in Hawaii. Pp. 77-84 *in:* Pest control into the 90s: problems and challenges (P.K.S. Lam and D.K. O'Toole, eds.). Applied Science Dept., City Polytechnic of Hong Kong.

Tamashiro, M., J.R. Yates, R.T. Yamamoto, & R.H. Ebesu. 1991. Tunneling behavior of the Formosan subterranean termite and basalt barriers. Sociobiology 19: 163-170.

Yates, J. R. III. 1997. Basaltic termite barrier. BTB 101: Installation instructions. VHS tape, 16 min., CTAHR Video Production Facility, University of Hawaii, Honolulu.