BORATE-TREATED WOOD FOR CONSTRUCTION

A Wood Protection Fact Sheet

Wood in its natural state has been a reliable construction material since the beginning of civilization. However, because wood is a natural, organic material, it is at risk of biodeterioration in certain circumstances – for example, in wet conditions or in areas with a high termite hazard. Wood can be protected from attack by pests with preservative treatment. Treated wood has long been used for decks, fences and other outdoor structures. In some cases, where risk of damage due to insects or fungi is especially high, it is used indoors as well, for structural framing and sheathing. Environmentally–benign borate preservatives are an appropriate choice to protect indoor wood products from wood–destroying carpenter ants, beetles, termites and decay fungi.

Sodium borate is a common ingredient in many household products and is also a wood preservative.

Forintek Canada Corp.

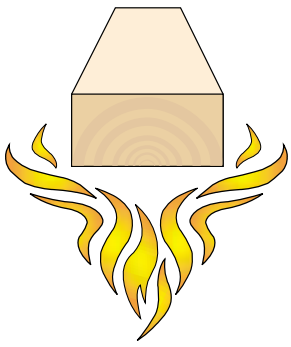
This entire house is protected with borate–treated wood products. All of the framing lumber as well as the wood sheathing panels will continuously resist decay and insect attack.

Photo courtesy Timber Specialties Co.

Importance of wood protection

Wood is biodegradable. Some fungi and insects can break down wood into its fundamental components, a very useful function in sustaining our natural forests but not a desirable process for wood in construction service. Fortunately, wood can be protected from pests, even in high-risk situations, enabling the use of this plentiful and renewable building material in structures around the world.

Fungi are a class of organisms, neither plant nor animal, that reproduce via spores. A few fungus species are capable of harming wood. Since they require water for growth, these decay fungi can be a risk if wood stays wet for too long. While most wood in buildings is well protected from environmental elements, excessive water exposure is sometimes unavoidable. Outdoor wood certainly gets very wet, but even indoor wood can be exposed to unintended moisture due to leaks caused by construction errors or other building failures. Insects can also be a threat for wood, especially termites. Termites are found in mild to hot climates worldwide, including parts of Canada and the U.S.



Many fire retardants for wood contain borates, which means fire-retardant wood may also provide for termite and decay protection.

Some species of wood contain their own protection against attack. For example, western redcedar, eastern white–cedar and yellow cypress (yellow–cedar) are “naturally durable” tree species that resist most insects and fungi. When other wood species are used in wet applications or in termite zones, long–term performance can be assured with wood preservatives. Preservative–treated wood is most commonly found in fences, decks, shingles, utility poles, marine piles and railway ties. Wood treatment is a well–established technology with a proven track record – treated wood has been used safely and effectively around the world for over 60 years. Treated wood is imperative in high hazard applications, as paint alone will not protect wood from decay fungi, and termite shields alone will not protect wood from termites.

The treatment process

There are many different registered preservatives available for wood, depending on the intended usage of the wood product. The most common treatment for lumber has historically been chromated copper arsenate (CCA), however other products such as ammoniacal copper quat (ACQ) and copper azole (CA) are being introduced to replace CCA for certain residential applications. Treated wood has been safely used in residential and other construction projects for decades, primarily for outdoor uses. Wood treated with CCA, ACQ or CA continues to be a popular choice for common exterior or wet applications such as batten strips, roofing, sill plates and fences. Borates are generally preferred for indoor uses such as framing lumber.

These preservatives are typically applied to wood in the same way: carried by water into the wood, under pressure. Wood products are loaded into a chamber, where a combination of vacuum and pressure are used to drive preservative chemicals into the wood. This is why treated wood is often called pressure–treated wood. The pressure is necessary because wood is relatively impermeable. Pressure treatment can usually only achieve partial penetration on most wood species, which means treated wood actually consists of an envelope treatment. If the envelope is breached, for example when a piece of lumber is cut, drilled or develops checks (cracks), untreated wood can be exposed and must be brushed or sprayed on the construction site with a field treatment preservative.

A few composite products, such as oriented strandboard, undergo a different treatment process. The preservative is added during panel fabrication.

Wood treatment alone does not affect the strength of wood. However, sometimes wood is incised for better penetration of the chemical in the pressure process – hundreds of small slits are cut all over the surface of the wood, which does reduce the strength of the piece. Incising is not necessary for borates.

Lumber being prepared for loading into a treatment chamber at Légaré Industries Ltd.

Borates are different

Unlike other wood preservatives, sodium borates remain water soluble. This means the chemical is mobile in the wood and can diffuse throughout the wood if enough water is present. When wet wood leaves the treatment chamber, the preservative continues to spread deeper into the pieces until the wood is dried for use in construction service. For this reason, borate treatment typically provides a deeper shell of protection than other preservatives. It is possible for borates to spread throughout the entire cross section, reducing concern of exposing inadequately protected wood when the piece is cut at the construction site. Borate diffusion even works in wood species that are hard to pressure–treat, like Douglas–fir. When dry, borate–treated wood is stable – no further movement of the preservative will happen in the absence of water.

Borate–treated wood should only be used where it is protected from major water exposure. Because borates are diffusible, the preservative can move out of a piece of wood under severe wetting. For example, if borate–treated wood is placed in a continuous stream of water, the preservative will slowly migrate out, eventually leaving the wood unprotected.

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Termite Test Sites

Forintek is working with collaborators in Japan and Hawaii on field tests. At this University of Hawaii test site, operated by Professor Ken Grace (above), lumber pieces are continuously exposed to the highly aggressive Formosan subterranean termite, which can destroy untreated wood in about a year. The borate-treated sample in the foreground (right) has been resisting termites since 1996, shown here completely unharmed after one year of testing. Note the dark line traveling from the ground, up the concrete block and reaching the wood: this is a shelter tube built by termites to protect themselves from exposure. Termites have found the borate-treated sample, but left it alone.

A natural pest controller

Borates are naturally occurring salts that result from the combination of two elements, oxygen and boron. Borates are found as mineral deposits around the world, with a particularly large store in the United States, in the deserts of California. They have long been used in hand soap powders and laundry boosters. Borates are also found in contact lens cleaners, eye washes, cosmetics, ceramics, medicines and dozens of other common products.

Because they are considered benign for human health, borates are perhaps the most suitable wood preservatives for interior construction components. Borates are also inorganic, which means they contain no volatile organic compounds (VOCs). VOCs are air pollutants sometimes associated with various health and odour complaints.

Without harming humans, borates are effective at inhibiting pests such as termites, beetles, carpenter ants and wood–rotting fungi. In fact, since the 1940s, borates have been successfully applied to wood products to protect them against insect attack. Two main classes of borate are used in wood preservatives: sodium borate and zinc borate. Disodium octaborate tetrahydrate (DOT), is a sodium borate specifically designed for treating lumber and other solid wood products. Zinc borate, a low solubility borate, is used for the preservative treatment of wood composites such as oriented strandboard, hardboard and wood–fiber/plastic composites.

The mode of action is not fully understood, but borates appear to disrupt the digestive process of the insect, causing it to starve. For fungi, borates are generally thought to work by preventing enzymic activity at the cellular level of the organism. A broad range of insects and fungi are inhibited by relatively low levels of sodium borate (approximately 0.2% by weight) in wood products.

Termites require a higher level of preservative, depending on the termite species. For example, the Formosan subterranean termite (one of the world's most economically significant pests for wood products) requires approximately 2% borates by weight in lumber. Termites will initially nibble the borate–treated wood and then spread the chemical through their large colonies during grooming activities in the nest. These termites quickly learn that further consumption of this wood is dangerous to the colony's health and move on to find a better food source.

Performance data

Borate–treated wood is used successfully in many places around the world to make construction and furniture products that are protected against a broad range of wood–destroying organisms. Field experiments provide the technical data to support continued use of these products. For example, borate–treated wood is undergoing long–term field testing against the voracious Formosan subterranean termite in Japan and Hawaii. In collaboration with Forintek, researchers at the University of Hawaii and at Kyoto University are monitoring treated and untreated wood samples placed outdoors on concrete blocks – protected from the rain but fully exposed to termites. The samples are simulating sill plate applications. Data gathered continuously since 1996 show that borate–treated wood neither substantially leaches nor is substantially damaged by termites. The tests demonstrate that borate treatment can provide a similar level of termite protection as CCA for the Canadian species group hem–fir. The borate–treated hem–fir also performs better than hinoki, a naturally–durable Japanese species.

In parallel laboratory and field testing of panel products, sodium borate–treated plywood and zinc borate–treated OSB are performing very well against termites. Field test data also exists for exterior uses of borate–treated wood. For example, borate–treated millwork, siding and window frames have been shown to successfully resist termites, if protected from leaching by a well–maintained exterior paint coating (primer coat and two top coats).

Design and construction guidelines

Borate–treated wood is used for applications inside the moisture resistant layer of the building envelope, in other words, inside the building paper or housewrap. This includes sill plates, which are sometimes perceived as a problem for borates due to risk of high moisture exposure because they are in contact with damp concrete. Field tests show that there is no significant borate leaching from sill plates. Borate–treated wood is also at no risk of leaching due to high humidity, unless it is subject to heavy and sustained condensation.

When specifying treated wood, one should always reference a standard to ensure the product will meet performance expectations. In Canada, designers should specify that wood be treated to Canadian Standards Association (CSA) Standard O80.34. In the U.S., specify treatment to American Wood Preservers' Association (AWPA) Standard C9 for plywood and C31 for lumber.

Different species of pests may require different levels of borate. Designers are advised to understand the level of hazard in order to specify an appropriate product. Guidance on matching specification to "Use Category" is addressed in the AWPA standard.

On a construction site, borate–treated wood looks and handles just like untreated wood. Borate–treated wood is colourless, although some treating facilities add a colourant for identification. It can be drilled, sawn, glued and finished as with any other wood. Manufacturers suggest all mechanical fasteners can be used. As far as we know, borate–treated wood can be used in contact with any other building material.

As with all treated wood, it is critical to specify a field treatment procedure for cut ends and holes. These specialized products are also used in remedial projects. When repairing a building, replace the damaged wood pieces. If the wood will still be at risk of biodeterioration, any new wood installed should be factory–treated wood. Any sound wood left in place that is still wet or at risk of attack should be treated with a field preservative. Note that field treatment is typically more expensive and less effective than factory treatment — it should not be considered an equal replacement for pre–treated products.

Borate–treated wood can be used in some outdoor applications, such as window frames, but only if adequately protected from the rain. This requires application and good maintenance of paint: a primer coat and two top coats of exterior grade paint. Varnishes and penetrating stains that have been tested do not seem to provide adequate rainwater protection for the borates.

During construction, it is recommended that borate–treated wood be kept covered and dry. However, temporary exposure of borate–treated wood to water during construction has never been found to lead to significant loss of the preservative. In most municipalities, borate–treated wood waste can be disposed in the same manner as untreated wood. However, consult local regulations for any particular requirements.

In termite zones, note that wood treatment alone won't keep termites away from untreated wood in the house, such as cabinets and picture frames, or from any other sources of cellulose like cotton and paper. Full termite protection requires more than one level of defense: treated wood for the structure, physical barrier to termites around the house, regular inspection for termites or leaks, and perhaps termite bait traps.

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Available products

For construction applications, wood can be industrially pre–treated before it arrives at the site or field–treated by brush or spray during or after the structure is built. Whenever possible, industrially pre–treated wood products should be used, as these will have optimal preservative penetration applied under strict quality control requirements.

Wood products pre–treated with borates are available for a wide range of construction applications. Borate–treated lumber and panels can be obtained in North America through many construction distribution channels. Other wood products such as heavy timbers are borate–treated on a custom basis. Borates can be applied to a variety of wood species. Forintek's research has shown that the common Canadian wood species Douglas–fir and species groups spruce–pine–fir (SPF) and hem–fir and are all treatable with borates to levels of protection that meet international standards.

Field treatments are most appropriate for *in situ* remedial applications and for treating the end–cuts of industrially pre–treated wood. Field treatments are also used on wood components that are sometimes difficult to purchase pre–treated, such as heavy timbers and logs. These treatments come in liquids, powders, pastes and solid rods. The liquids can be applied by brushing, spraying or dipping. Some liquid formulations contain glycols to carry the borate into dry wood, as borates will only diffuse through wood on their own if the wood is fairly wet. Solids and pastes are inserted into drilled holes in the wood. Field treatments can also be used on composite materials (wood and some non–wood products) — consult manufacturer's instructions.

Most wood products pre–treated with borates are sold as kiln–dried–after–treatment products. Their costs are comparable to other pressure–treated products that are dried after treatment. Using borate–treated wood products adds a small price premium versus untreated lumber. However, this added cost is smaller than the price of future termite damage repairs.

Borate treatment can also be applied to other construction products, such as expanded polystyrene insulation (EPS). This allows for a termite–resistant structural insulated panel (SIP), where borate treatment protects both the OSB panels and the EPS core.

Special note on manufactured housing

Treated wood is a must for certain export markets, for example regions with heavy termite risk. Since suppliers of manufactured housing have little control over any other measure for termite control, it's important to provide protection for the wood itself. Environmentally–benign borates are well–accepted in markets where there is also sensitivity to health issues.

Forintek Canada Corp.

Forintek is Canada's wood products research institute. Established as a private not-for-profit corporation in 1979, Forintek is an amalgamation of two former public laboratories whose history dates back to 1913. To this day, Forintek continues to provide leading-edge technical support to the solid wood products industry. As part of its broad program, Forintek is Canada's primary wood industry–based participant in worldwide termite research and a major North American supplier of information on wood preservative treatment technologies and durability performance of wood. Visit www.forintek.ca.

For more information

For help with durable wood construction and detailed information on termites, treated wood and much more, go to:

www.durable–wood.com

(Forintek Canada Corp. and the Canadian Wood Council).

For more on borates:

www.advance–guard.com
(Timber Specialties Co.)

www.borax.com (U.S. Borax)

www.dricon.com
(Arch Wood Protection)

To find suppliers of borate-treated wood products or borate field treatments on the web, try these search words: termite or borate combined with wood, lumber, plywood, OSB, log or SIP.

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This document is also available in French.
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