

Technology and Trends in Sustainable Tropical Hardwoods



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Technology and Trends in Sustainable Tropical Hardwoods

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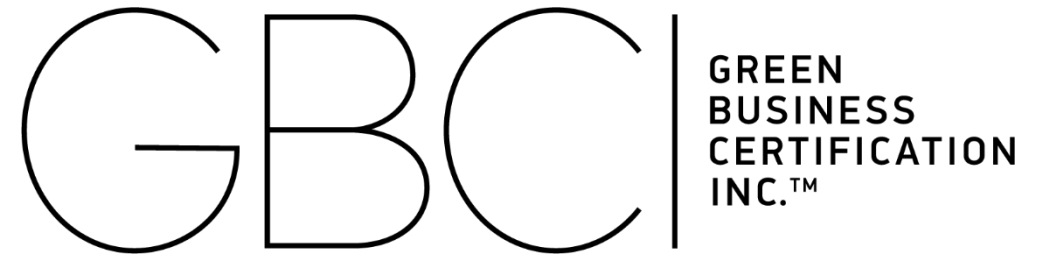
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Purpose and Learning Objectives

Purpose: There is no substitute for the natural beauty of newly installed tropical hardwood, but keeping it looking great and achieving the desired performance over time require careful attention to detail. Choosing the best hardwood species and specifying the appropriate fastening and finishing systems will ensure an aesthetically pleasing, low-maintenance, and successful design in terms of installation, performance, and appearance. This course discusses wood species specification, installation techniques, and finishing methods for tropical hardwoods in conventional and sustainable buildings. As well, international programs that are used to successfully determine sustainability are examined.

Learning Objectives: At the end of this program, participants will be able to:

- identify the characteristics of sustainable tropical hardwood options related to appearance, durability, and other performance issues
- investigate the different tropical hardwood options available from different locations around the world
- recognize the different sustainability certifications that are applicable to the selection of tropical hardwood, and
- specify sustainable tropical hardwood, including the means of installation and finishing based on best practices.

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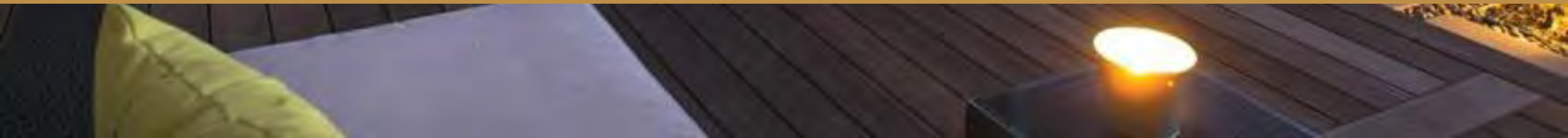
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Summary





Introduction



Introduction

Anyone with experience in working with wood quickly discovers the diversity among the individual species. Each one has unique properties that determine the suitability for different uses.

There are many great choices when it comes to selecting a species of wood for decking, siding, trim, and finish work. Hardwoods harvested from tropical locations around the world have become a popular choice because of their beautiful appearance and natural durability, especially for exterior use on buildings.

However, architects looking to use tropical hardwoods on buildings often receive contradictory information regarding characteristics, sustainability, and even legality of different tropical wood species. Once a suitable species is determined, questions will certainly arise on the best practices for installation and finishing.



Introduction

Shown here is batu hardwood used to create a sign band facade area that is held in place with resilient rainscreen clips and finished with a polymerized tung oil stain in a black walnut color.

Batu provides an aesthetically pleasing design and is certifiably sustainable.





Natural Beauty and Durability:
The Amazing Diversity of Tropical Hardwoods



Natural Beauty and Durability: The Amazing Diversity of Tropical Hardwoods

Tropical hardwoods have exceptional strength, hardness, and beauty. There is no comparison in terms of performance and quality of the wood. Producing long-length and relatively defect-free lumber, tropical hardwood trees grow tall and straight in the most lush and verdant climates on the planet. Imported primarily from South America and Southeast Asia, these naturally durable tropical hardwoods have grown in popularity over the past few decades.

Long-lasting tropical hardwoods are an ideal choice for decks, siding, and outdoor living spaces because of their strength and ability to hold up against the weather.



Natural Beauty and Durability: The Amazing Diversity of Tropical Hardwoods

The tropical hardwood market today includes a wide variety of incredible woods. Ipé may be the most well known, but there are plenty of other sound choices when it comes to rot-resistant, durable tropical hardwoods. From South America, ipé, cumaru, garapa, massaranduba, tigerwood, and even purpleheart have been used in exterior applications. From Southeast Asia, batu, red balau, yellow balau, *Manilkara*/South Pacific redwood, and merbau are all rot-resistant choices.

In fact, our tropical rain forests have hundreds of commercially marketable species that are uniquely beautiful as well as naturally durable. These woods can be used successfully in exterior applications. The key is to understand the potential issues and design accordingly.

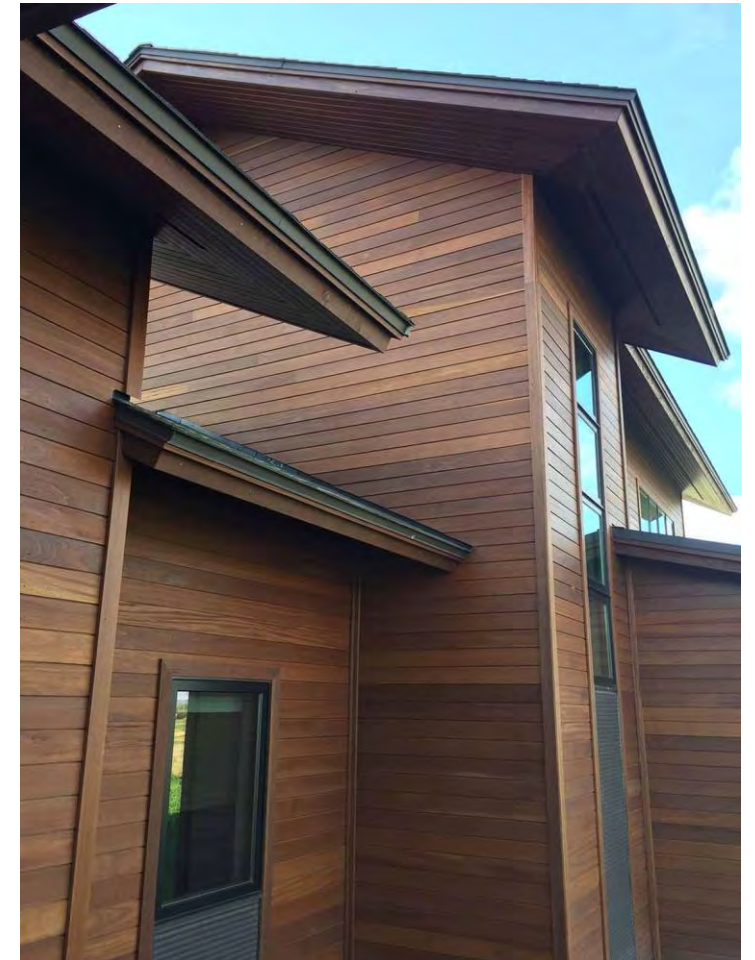


Natural Beauty and Durability: The Amazing Diversity of Tropical Hardwoods

Tropical hardwoods first started showing up on outdoor decks and commercial projects such as boardwalks, where they provided a significant upgrade in appearance and longevity compared to other wood species and composites, including softwood materials that were finished or treated with preservatives.

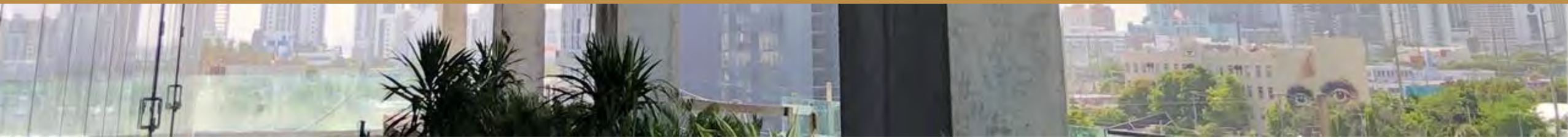
Tropical hardwoods soon caught on for use as exterior siding and rainscreen cladding. Additionally, these durable hardwoods started to be used instead of other more costly materials for wood trim, soffits, and exterior wall panels. Furthermore, these hardwoods are also being fabricated into outdoor furniture and structural timber framing due to their pleasant appearance, durability, and longevity in outdoor environments.

Tropical hardwoods have similarly been used for many years as interior flooring.





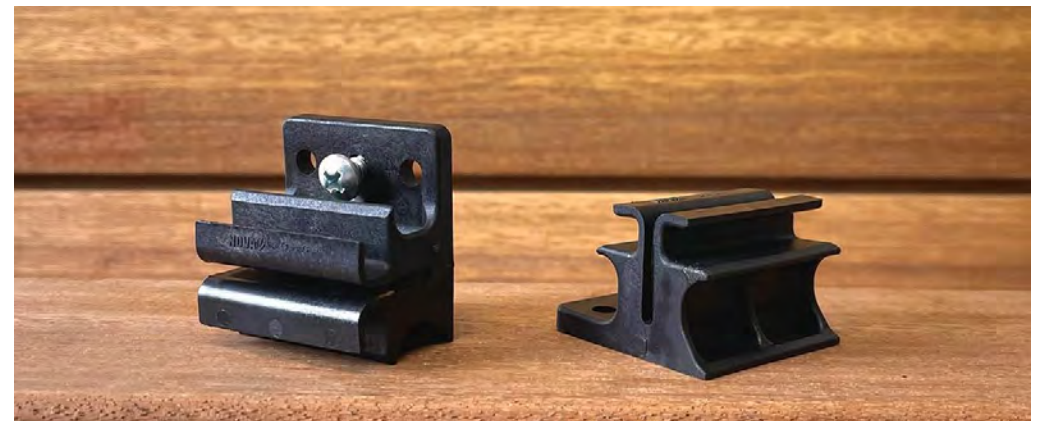
Critical Success Factors in Designing with Tropical Hardwoods



Critical Success Factors in Designing with Tropical Hardwoods

Successful designs with tropical hardwoods require paying close attention to the installation and finishing details as well as a complete understanding of the species of hardwoods that are specified in the project. The most common reason for project failure is not designing to accommodate the natural expansion and contraction of wood due to moisture exposure and varying humidity levels. This situation is easily avoidable by specifying the proper spacing between boards, fastening system, ventilation, and finishing—which helps prevent moisture from penetrating the wood unevenly.

The latest technology in hardwood installations is the use of resilient fastening systems. Recognizing that in exterior conditions, wood will continue to shrink and swell with moisture content changes over the seasons, an attachment system that accommodates this natural movement is required. These innovative clip systems also make installations faster and easier.

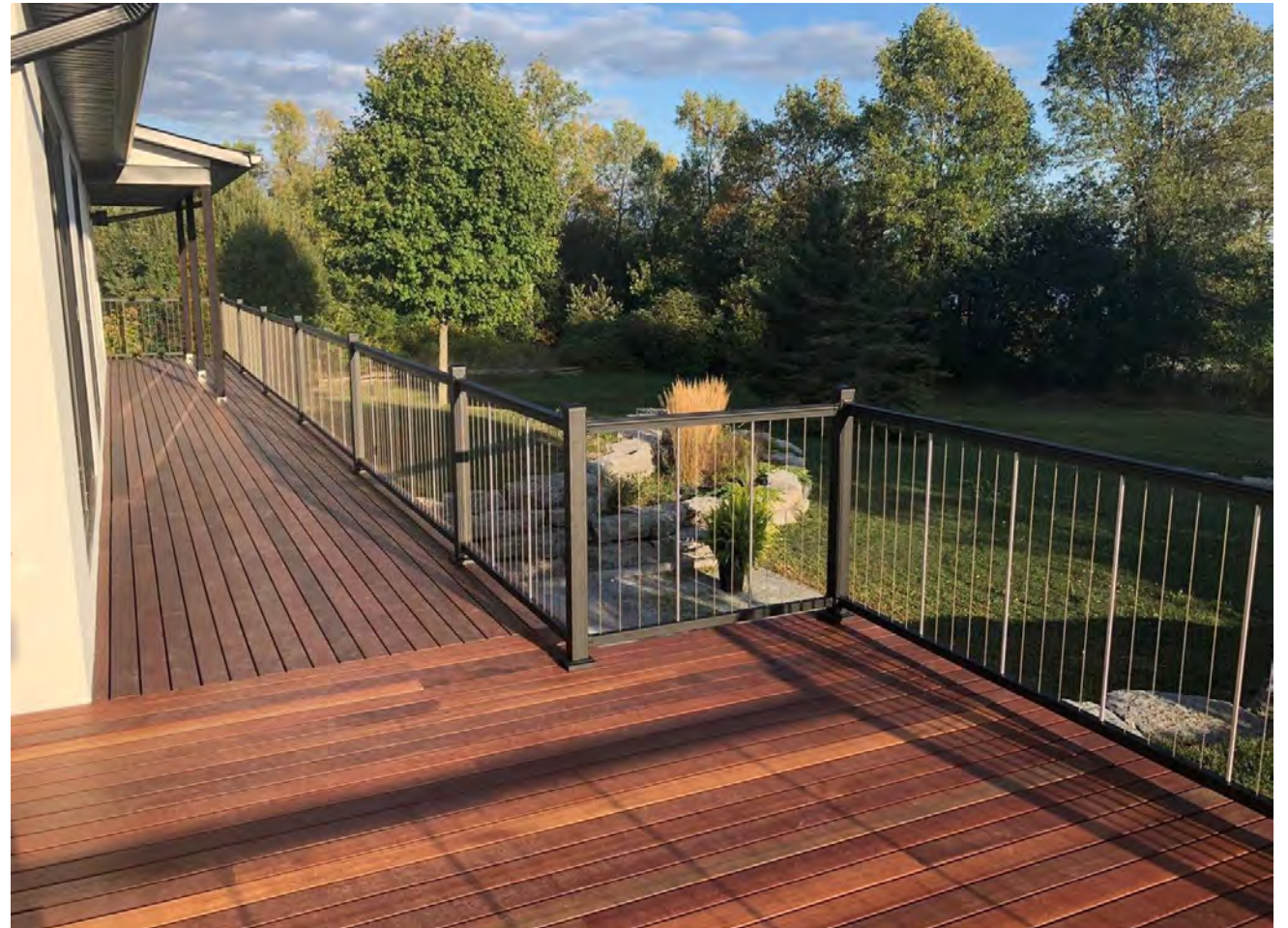


Examples of innovative clip systems for decking and siding

Critical Success Factors in Designing with Tropical Hardwoods

Another common complaint is just how quickly a beautiful hardwood installation begins to weather. Low-quality linseed or vegetable oil finishes offer next to nothing to protect the material and do little to help keep the wood looking beautiful. Significant color degradation can be seen in as little as three months after installation.

Finishing systems have improved dramatically over the past few years to include nanotechnology water-based products, synthetic oils, and tung oil products. Featuring ultraviolet (UV) protection and color retention, these new finishing products have been shown to keep projects looking fresh for notably longer.



Selection Criteria and Issues

You don't need to have years of experience or a forestry degree to select and specify tropical hardwoods. However, some basic knowledge is helpful to avoid confusion. Let's delve into more detailed information regarding specific characteristics and species of tropical hardwood.

Durability: The degree of durability varies between different tropical hardwoods. Some are highly durable and rot resistant, while others, even though they may be dark in color and heavy, are not rot resistant at all. One of the most popular hardwoods used for exterior decking during the 1990s and 2000s, primarily in the Northeast United States, was cambara *Erismia uncinatum*. These decks tended to rot and decay within 10 to 15 years, similar to tight-knot cedar or redwood. Red meranti, another very popular species used primarily in the Northeast and mid-Atlantic regions of the United States, is actually a mix of individual species within the *Shorea* genus, and many of these species are not durable at all. Therefore, it is absolutely critical to specify, preferably by the complete scientific name, a durable species of tropical hardwood. Checking the supplier's warranty against rot and decay is a prudent measure as well.

Appearance: Like all hardwoods and softwoods, the natural color in tropical hardwoods can vary significantly within a single species of wood. Ipé, for example, has a wide range of colors from dark brown to olive green to deep red. When left unfinished in exterior conditions, all these tropical hardwoods eventually become a gray and/or silver color.

Selection Criteria and Issues

Texture: The texture of some tropical hardwood species can become rough over time. This change in texture is referred to as raised grain and is common in some woods, such as cumaru. This is an especially important consideration for exterior decking, particularly if there will be people walking barefoot on the deck. Frequent pressure washing will exacerbate the roughness, which can generally be mitigated by sanding after pressure washing.

Tannin Bleed: In a few species, tannin bleed can be highly apparent, which is often undesired. For example, merbau tannins bleed a dark blood red. A typical second-story deck open to the ground below will stain everything underneath the structure.

Stability and Movement: When timber is initially cut, it is called unseasoned or green wood, meaning it has not undergone any drying treatment and contains a high moisture content (MC). Hardwoods are then either air dried or kiln dried. Once the cut wood dries below its fiber saturation point, it begins to shrink as its MC decreases. There is a direct linear relationship between shrinkage and MC below fiber saturation. Conversely, when dry wood is exposed to rain or humidity, it will absorb moisture, and the wood will swell.

Selection Criteria and Issues

The majority of customer complaints are the result of wood products either taking on moisture and swelling or losing moisture and shrinking. The boards on decks built too close to the ground without adequate spacing edge-to-edge or adequate ventilation on the underside of the deck will likely cup, buckle, and warp. Most hidden fastener systems for decking do not allow for swelling of boards after installation.

Some tropical hardwoods, like massaranduba, are known for their high movement with changes in the MC, while others move much less. This is important when attaching wood to a structure since hardwood movement caused by moisture changes has been measured to exert upward of 10,000 pounds per square inch of pressure. That amount of pressure has been known to push decking off its supports or even bend and shear fasteners.

Since wood is dimensionally stable with changes in temperature, swelling and shrinkage in tropical hardwoods is therefore a direct result of changes in moisture content in the wood. Hence, all installations must have adequate spacing, fasteners that accommodate that movement, and adequate ventilation.

Selection Criteria and Issues

Checking, Warping, and Cupping: All tropical hardwood species will exhibit some degree of checking (lengthwise separations in the wood grain), cupping, and warping when allowed to fluctuate from very dry to very moist conditions. The best way to minimize this movement is to slow the flow of moisture into and out of the boards, which requires waxing end cuts and coating all sides with a high-quality finish.

Common Names vs. Scientific Names: Understand that even though tropical hardwoods may have the same common name, they can be vastly different. Tropical hardwoods are called by many different names. Some common names such as mahogany or meranti are used as a broad reference to include hundreds of different species of wood. Therefore, it is important to identify wood by the genus and species. Doing so will ensure the wood specified will have the desired characteristics.



Choosing Tropical Hardwood Species



Choosing Tropical Hardwood Species

Recalling the previous criteria, we will now look at two of the most common species of tropical hardwoods that exhibit exceptional characteristics and very minimal undesirable qualities: ipé and batu.

Ipé from South America

This is perhaps the best-known and most publicized tropical hardwood. Ipé (pronounced ee-pay) is a very dense, nonbuoyant wood with excellent durability. Dense wood is appealing because density is associated with strength and hardness. Another great quality is that it can survive for 50+ years with very little maintenance compared to other hardwoods. Ipé has a high tannin content, allowing it to remain very rot resistant and maintain an attractive appearance. It's also great for decks exposed to direct sunlight because wood conducts heat more slowly than PVC (polyvinyl chloride) decking, meaning that it remains cool to the touch for longer.



Is Ipé Sustainable?

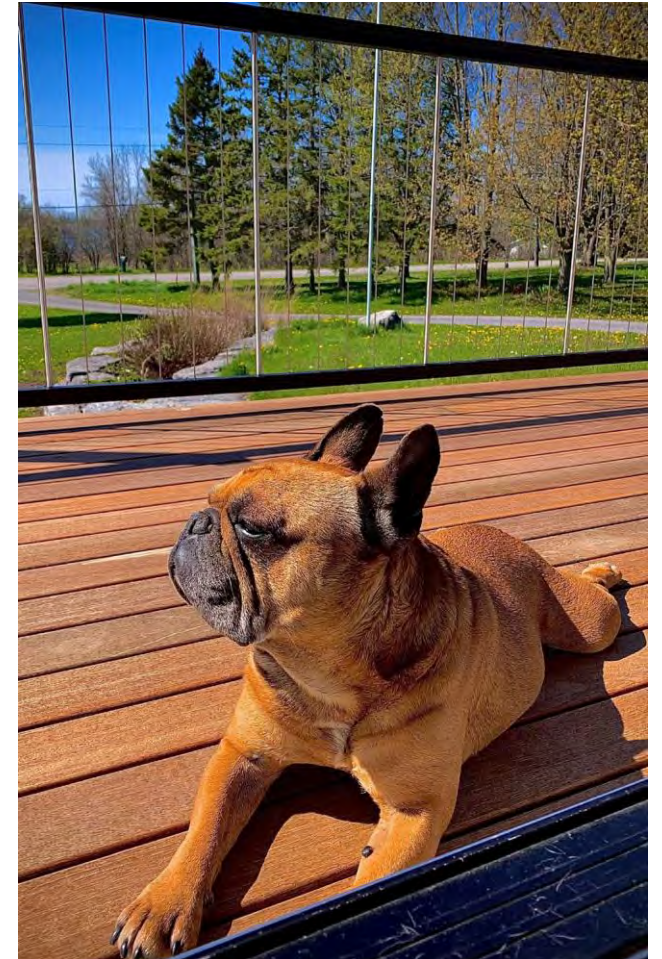
Ipé clearly sounds like a great choice, but it also appears that it has become a victim of its own success. The difficulty of cutting and milling this very hard wood combined with high demand means that it comes with a comparatively high price. Increased demand has also led to some concerns with sustainability due to overharvesting. Expanded harvesting has been high enough in recent years that there is speculation that it may soon be listed as a threatened species by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This is an international agreement between governments whose aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. This pending designation has caused inconsistent availability and significant swings in market prices. Going forward, ipé may not be a sustainable or cost-effective viable option.



Batu as an Alternative Tropical Hardwood to Ipé

There has been a trend to use tropical species other than ipé that are more available and sustainable and still appropriately suited for use as decking, siding, and other exterior applications. One of these alternative species is a tropical hardwood referred to as batu or red balau, which is emerging as a preferred and highly available choice. The name batu is the generic or local name given to red balau, which is in the Dipterocarpaceae family, the *Shorea* genus, and the *guiso* species.

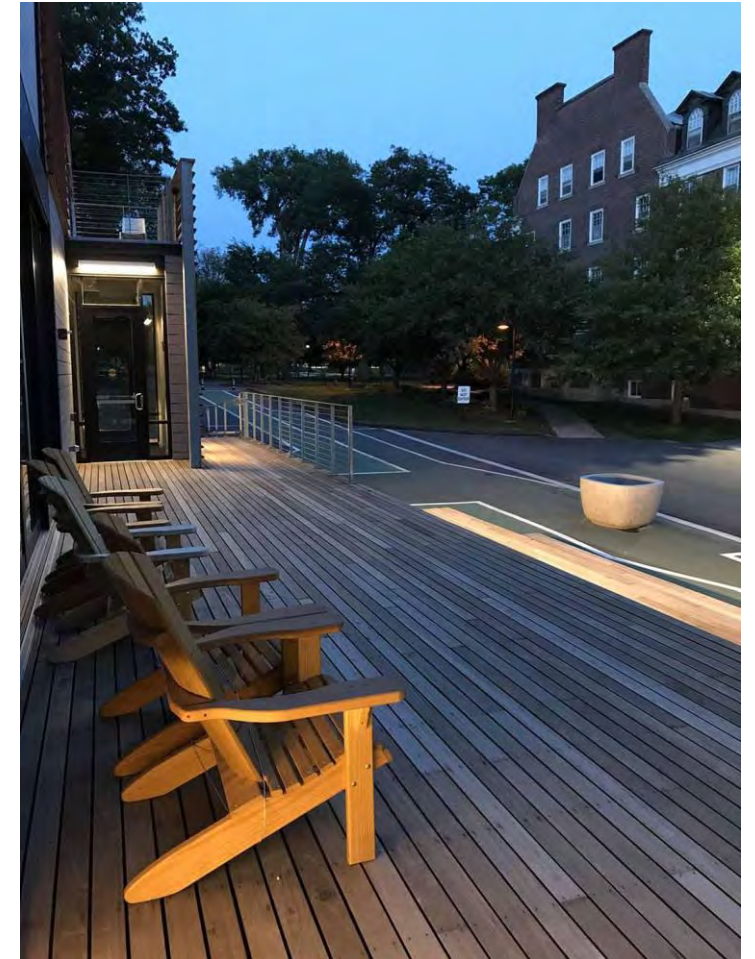
Batu has sometimes been grouped with mahogany decking, which is based more on its red coloring and straight grain than its natural strength and durability. For example, red meranti is a group of species, sometimes called Philippine mahogany, which is naturally found in Southeast Asia, specifically in Malaysia, Indonesia, and the Philippines. The heartwood of meranti trees is considered only moderately durable, and it can have a much wider range of coloration than batu. Similarly, cambara is another medium-density, low- to moderate-durability wood sourced from South and Central America. The heartwood is typically a uniformly dull pink, pinkish brown, or golden brown. It is important to note that neither meranti, cambara, or batu is derived from the same family of trees as genuine mahogany.



Batu as an Alternative Tropical Hardwood to Ipé

Naturally grown genuine mahogany (*Swietenia macrophylla*) is not readily available in typical decking or siding boards and is prohibitively expensive for exterior applications. Plantation mahogany, primarily grown on the island of Fiji or Honduras, is more available but lacks the strength and stability of natural forest-grown genuine mahogany. The generic grouping of batu or red balau as a mahogany has caused confusion since batu is the only durable species in this group.

The key point here is to do the research and be sure to specify a truly durable species of wood. Avoid meranti, Philippine mahogany, cambara, and plantation mahogany, and in all cases, check the supplier's warranty against rot and decay. In this light, genuine batu, specifically red balau, is often selected as the preferable choice.



Batu, Red Balau Traits

Batu is currently imported into the United States by at least a half-dozen different importers from forests in Indonesia and Malaysia. Most people compare it to ipé as it has several shared characteristics.

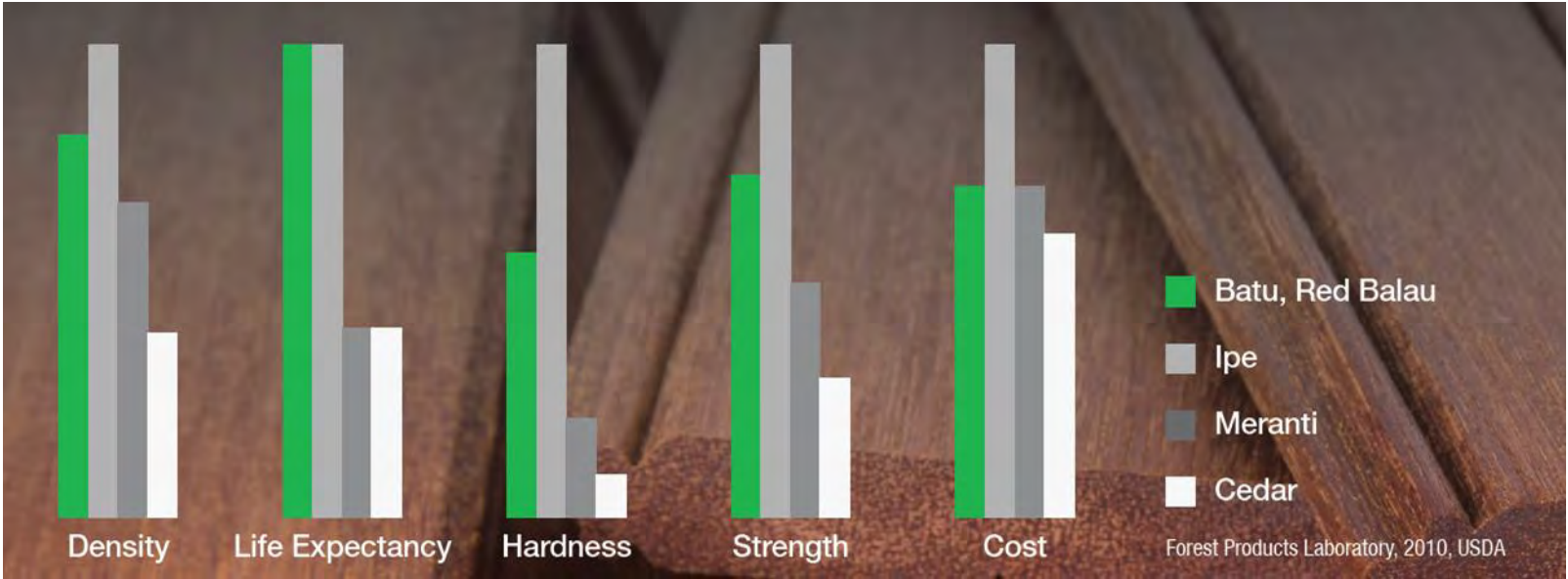
Batu shares a high density and hardness but is easier to work with than ipé. Batu will also last 50 years or more but is a lighter-weight and more color-consistent product.

It is readily available in a wide variety of sizes and is cost effective, typically being quoted at 30–40 percent less than ipé.



Batu, Red Balau Traits

While the price alone can make batu more appealing than ipé, it also has some other desirable qualities that set it apart. Consistent color and grain are probably the most notable from a design standpoint. Its natural, reddish-brown tone can be preserved or allowed to weather to lighter tones that are all visually appealing. Batu is rated in the highest durability class of hardwoods and is highly scratch resistant. Batu also achieves a Class A fire rating—the highest tested rating for tropical hardwoods. In order to address stability from moisture movement, batu is commonly kiln dried whenever it is used for a wood construction product.



Batu, Red Balau Traits

As batu is typically kiln dried and somewhat less stable than ipé, it can't be used as a direct replacement for ipé in close-to-ground or close-to-water decking applications. Installing at a minimum of 36 inches above grade is recommended by most suppliers for 1x6 and 5/4x6 nominal boards, and 16 inches above grade is required for 1x4 and 5/4x4 boards.

Another notable difference with batu is that it doesn't have the same sustainability concerns of ipé. It is readily available from forests that are sustainably harvested with full chain-of-custody documentation. Note that species identification is important here since there are literally hundreds of species of wood under the *Shorea* genus, many of which are critically endangered. Hence, verifying that the wood is only sustainably harvested and legally verified as batu (red balau) is significant.



Yellow Balau: An Alternative to Batu (Red Balau)

A relatively new species in the North American marketplace, yellow balau (*Shorea laevis* and *Shorea glauca*) is one of the most popular species throughout Europe and Australia for hardwood deck construction. It is often referred to as Golden Batu or Bankara.

Yellow balau is a naturally durable species with an interlocking grain, which gives decking a smooth, even texture and ensures a long service life.

The excellent mechanical and physical properties of yellow balau compare favorably to other well-known species such as ipé and cumaru.

These natural properties give yellow balau a hard-wearing character, which makes the species a perfect choice for residential and commercial projects where there may be a high flow of foot traffic.



Yellow Balau: An Alternative to Batu (Red Balau)

Due to the high specific gravity and naturally high silica content of the species, yellow balau has a very robust natural durability, which allows for use in marine environments.

With a mixture of stunning golden, brown, and red tones, yellow balau offers a unique color range that is similar to teak, blending beautifully with natural surroundings and enhancing any outdoor project.

Yellow balau darkens to a warm mahogany color when exposed to UV rays and will eventually weather to a beautiful, maintenance-free, silver patina if left unfinished.

Yellow balau decking should be carefully kiln dried to ensure its longevity and stability.





Review

Explain why using the scientific name vs. the common name of hardwood is so important.



Answer

Tropical hardwoods are called by many different names. Some common names such as mahogany or meranti are used as a broad reference to include hundreds of different species of wood with many differing characteristics.

Therefore, it is important to identify wood by the genus and species. Doing so will ensure the wood specified will have the desired attributes.



Installing Tropical Hardwood



Installing Tropical Hardwood

Once tropical hardwoods are selected, certified as sustainable, and delivered to the construction site, they need to be installed in a manner suitable to the material.

Since tropical hardwoods are denser and stronger, the installation tools and techniques used need to match the characteristics of the wood.

Next, we'll outline some of the best installation practices for tropical hardwoods.



Storage and Handling

For best results, tropical hardwoods should be stored out of direct sunlight and not be exposed to weather before installation.

Once it is delivered to the jobsite, the material should be kept off the ground by placing a few pieces of lumber underneath the stack. Cover the material with a tarp to protect from sun damage and rain.

Note that air-dried hardwood must be allowed to acclimate to the ambient humidity and moisture content on the jobsite prior to installation, which can take a few weeks.

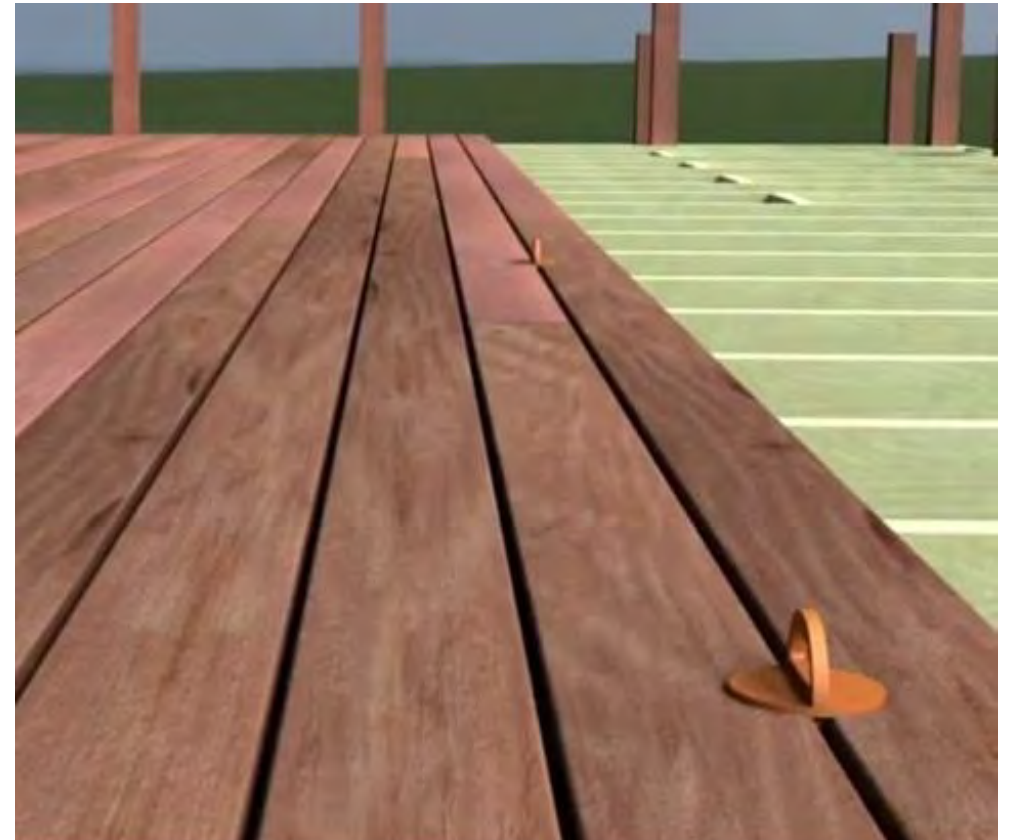
By contrast, kiln-dried hardwood can be installed after a few days of acclimation.



Deck Installations

One of the typical uses for tropical hardwoods is for outdoor decks. Generally, in coordination with applicable codes, 1x4 and 1x6 decking is safe to install when joists are spaced at 16 inches on center. When joists are spaced 24 inches on center, 5/4x4 or 5/4x6 decking is required. If installing the decking on an angle, joist spacing should be 12 inches on center for best results.

The spacing between the deck boards will depend on whether kiln- or air-dried wood products are being used. For kiln-dried decking, spacing between boards should be at least $\frac{3}{16}$ inch for 4-inch decking and $\frac{1}{4}$ inch for 6-inch decking. For air-dried decking, the wood must acclimate on the jobsite until the material is below 15 percent moisture content first. Then the spacing can be set between boards at $\frac{3}{32}$ inch for 4-inch decking and $\frac{1}{8}$ inch for 6-inch decking. This space between boards will allow air circulation and room for expansion and will provide the proper spacing as boards become fully seasoned.



Ensure proper spacing using a gap tool

Deck Installations

Regarding ventilation under the deck (i.e., ground side), the deck surface should be at least 16 inches above the ground when using 1x4 or 5/4x4 decking material. When using 1x6 or 5/4x6, the deck should be constructed a minimum of 36 inches off the ground. These heights are recommended because there must be adequate air circulation underneath the deck in order to prevent cupping and warping of boards.

In locations that are closer than 16 inches to the ground or an understructure, only 1x4 or 5/4x4 boards are recommended. Further, the spacing of the boards should be increased by at least 1/16 inch up to 1/4-inch total between boards. Additional clearance is recommended in locations that are typically wet or above water. In close-to-ground applications, 60 inches or less above the ground, a vapor barrier is necessary to prevent moisture from absorbing into the underside of the decking boards.



Ensure a minimum of 50% open space below for airflow

Exposed Decking Fasteners

Several different options are available for fasteners and for fastening techniques. It is recommended that stainless steel screws are used, installed through the face of every board with two screws per joist. Predrilling is always required when face screwing. A countersink drill bit with a positive stop should be used to ensure that all screw heads end up at a consistent depth.

Nonstainless fasteners are not recommended because they will cause discoloration near the fastener and tend to deteriorate quickly when exposed to weather. In particular, do not use carbon-steel screws. Stainless steel screws will bend somewhat, allowing the wood to move with changes in moisture content, unlike carbon-steel fasteners, which can snap due to stress from swelling and shrinkage.

Several manufacturers sell a system for countersinking the screws and then plugging the hole with the same species of hardwood; this creates a nearly invisible fastening system.

Hidden Decking Fasteners

The only hidden decking fastener systems recommended for tropical hardwood use are those that allow for the natural expansion and contraction of the wood as it takes on seasonal moisture. When the proper hidden fasteners or clips are used, no face drilling or attachment is needed, which allows for a cleaner finished appearance and avoids undue stress from movement being transferred to the screws and substrate or framing.

New to the market are nylon clips infused with glass fibers. These clips are nylon 6/6 reinforced with 13–15% glass fibers, providing extra durability, tensile strength, and flexibility that will complement the expansion and contraction of tropical hardwood boards. These new clips meets ASTM D638, “Standard Test Method for Tensile Properties of Plastics,” and ASTM D790, “Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.”

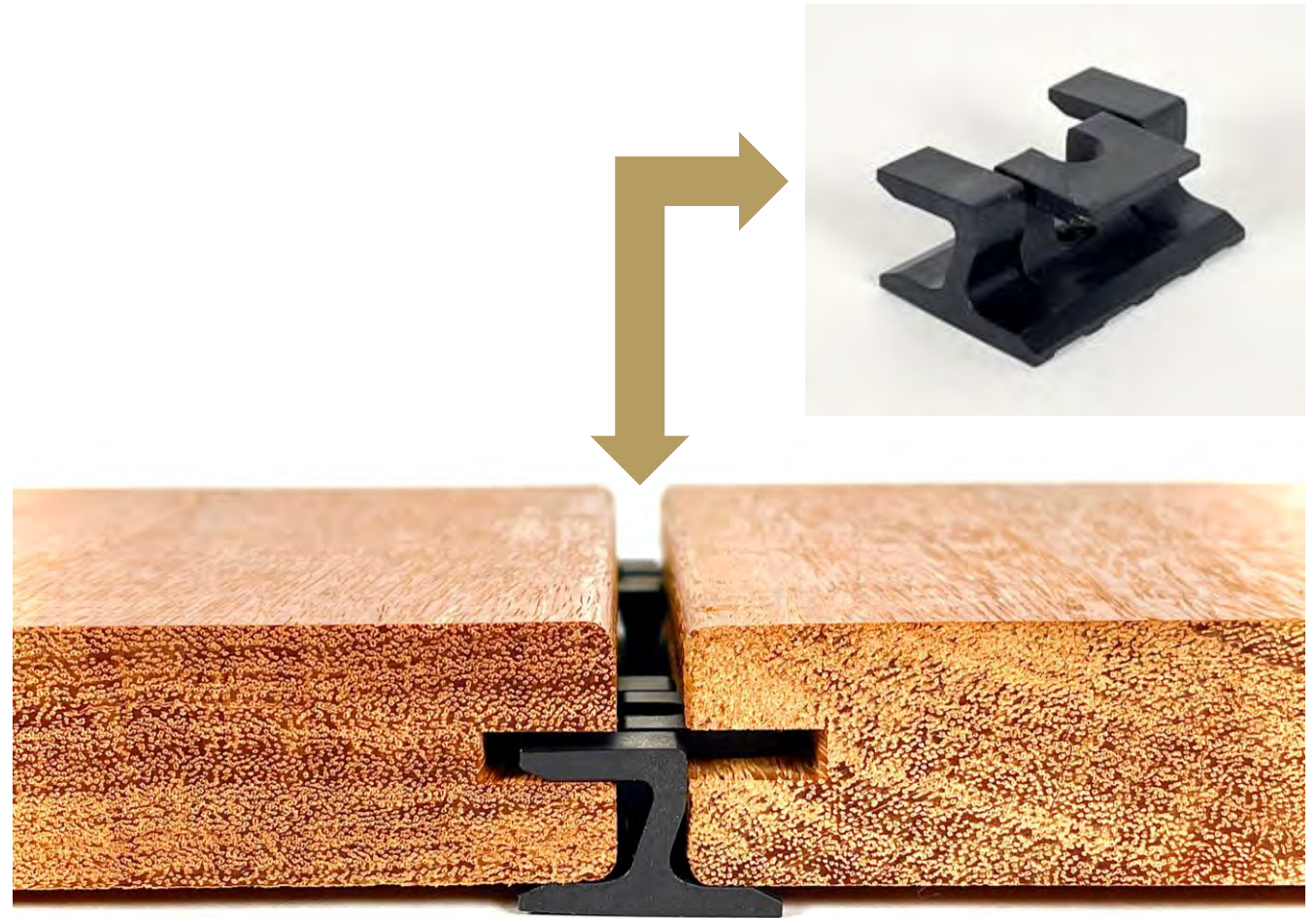


Hidden Decking Fasteners

Here, you can see how the clip is installed between the deck boards.

Typical deck boards can swell up to 3/16" in width. The clip will compress to absorb this expansion.

When the wood later dries out, the hidden fastener spring clip will move the boards back into place, centered perfectly and securely fastened to the joist below. Finite element analysis (FEA) to model stress, extensive physical testing, and case studies were done to ensure the clip performance.



Siding Installations

Tropical hardwoods are available in traditional siding profiles as well as profiles suitable for rainscreen siding applications. For rainscreen installations, siding is commonly run horizontally using 1x4, 1x6, or 1x8 siding boards. However, it can also be run vertically.

To function properly, an air gap of approximately 3/4 inch is needed between the siding and the sheathing, which should be covered with a water-resistive barrier.

To create that gap and hold the siding in position, a resilient nylon or aluminum clip is the recommended best practice. Other methods, such as furring strips or channels, don't have the same durability or capability to accommodate the movement associated with tropical hardwood material.



Rainscreen Installations

The issues with mounting rainscreen siding properly are much the same as installing decking properly: allowing for the natural movement of the wood due to expansion and contraction from moisture content changes.

One of the benefits of using a clip-based rainscreen system is that the spacing between boards is set by the clips themselves.

As such, the clips that are used to hold the siding in place should provide the same resilient qualities as the deck clips discussed already.

The best ones are made from marine-grade nylon or aluminum and attached using exterior-grade screws. Typically, clip-based rainscreen installations do not require stainless steel fasteners because the fasteners are behind the siding and fastened to the studs through the sheathing. However, stainless steel fasteners are recommended for installations near salt water.





Finishing Tropical Hardwood

Finishing Tropical Hardwood

The final step for any wood-based installation is the finishing. As with most other species, there are choices and recommendations for how this is best done for tropical hardwoods. This starts with some general recommendations about proper jobsite storage, as noted earlier, so that the wood has the chance to acclimate before being finished.

If the wood is kiln dried, it should be ready to receive finish quickly. If it is air dried, the wood must reach a moisture content of 15 percent or under in order to accept a finish. (This typically only applies to ipé since virtually all other tropical hardwoods are sold as kiln dried.)

It is important to prepare the wood before applying a penetrating oil stain to get rid of any underlying surface stains. Two common methods to prepare the wood are pressure washing and belt sanding with the grain; orbital sanding works for small jobs. However, these preparation techniques are typically not required for newly purchased hardwood.

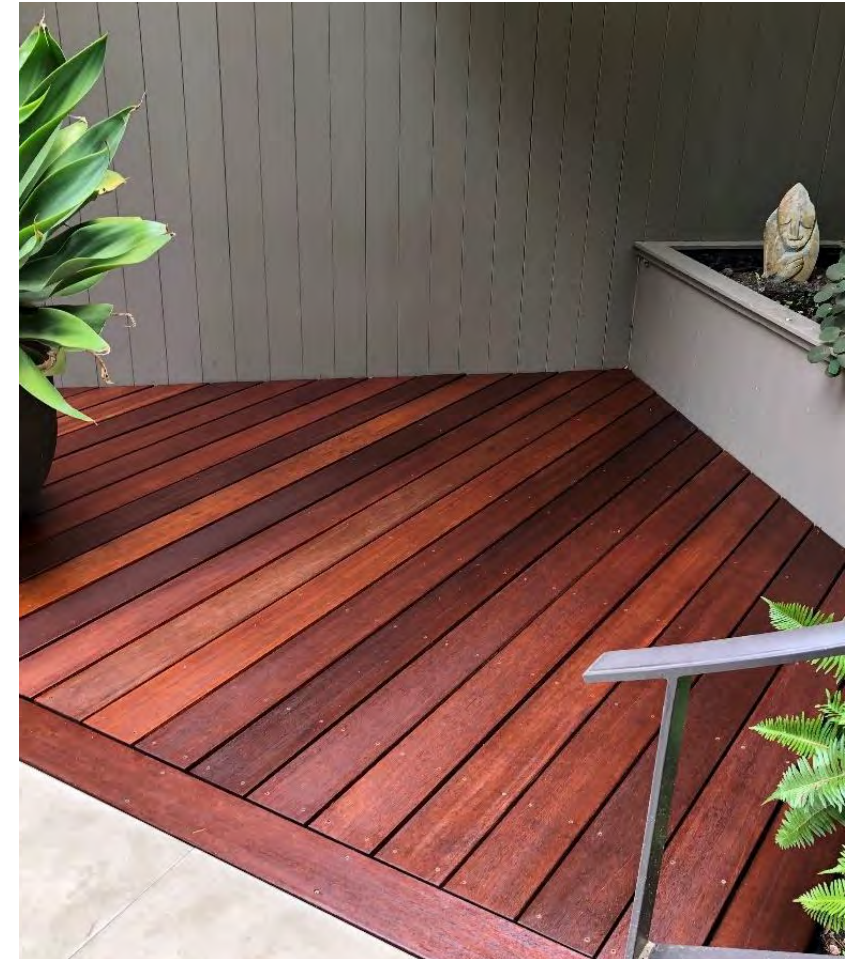


Finishing Tropical Hardwood

Part of the reason that tropical hardwoods are used on building exteriors is the natural appeal of their color and grain texture. In many cases, that means that there is a desire to leave the wood unfinished. The hardwood itself will hold up just fine without finishing, but its appearance will change.

The ultraviolet rays of the sun will lighten the color over time, eventually turning the wood to light shades of gray or silver. Further weathering and usage, particularly on horizontal deck surfaces, may cause other unwanted conditions such as a raised or rough grain and/or surface checking.

In order to limit checking and allow exterior hardwoods to acclimate to the local climate over time, it's recommended to apply at least one initial coat of an oil-based stain before or immediately after installation. Hardwoods installed without any such finish may develop additional checking or warping and a rougher grain. If you choose to not refinish the hardwoods, they will gray out over time and will require pressure washing or sanding to achieve their original color.



Finishing Tropical Hardwood

Conversely, some people assume that they can use a semitransparent or solid body stain on tropical hardwoods the same way they do on softwood lumber. While those stains may be composed of a penetrating oil, they also permanently change the color and appearance of the wood.

This is assuming that these products actually penetrate the wood and don't end up forming a surface layer or film, which will most certainly flake after prolonged exposure.

As such, these stains essentially negate the aesthetic reasons to use tropical hardwood in the first place. There are much less expensive woods that can be used if a solid stain color is desired.

Hence, semitransparent and solid body stains are virtually never used on tropical hardwoods.



Finishing Tropical Hardwood

The best practice for finishing tropical hardwoods is to use a high-quality penetrating oil. However, not all oils are alike. Linseed oil (vegetable oil) finishes are popular because of their low cost. However, they do not perform well, and weathering can generally be observed within just a few months of exposure. Additionally, linseed oil is highly susceptible to mildew and mold, unlike higher-quality oils, such as tung oil.

Performance among various oil-based stains is not consistent due to variations in the levels of UV blockers and polymerization of the oil itself. Long-term maintenance issues are common with linseed oil finishes and finishes that use lower-quality UV blockers. Most importantly, each refinishing will require a deep pressure washing or sanding in order to remove the graying or weathering that has occurred.

A preferred alternative to linseed oil is tung oil, which is a natural, sustainable oil made from the nuts of the tung tree, grown mainly in China. It has natural qualities that allow it to penetrate deep into the wood and harden as it dries to help prevent checking and cracking of the wood. Nevertheless, it remains flexible enough to move with wood as it naturally expands and contracts. It also provides a good degree of resistance to water, mildew, and mold and, as such, should be applied on all sides of each board. (An alternative for nonexposed sides of decks and siding is to use a wood wax [end wax] on the back sides of the wood. This is recommended only in situations where the wood is placed closer to the ground than the manufacturer's specifications. Otherwise, tung oil is the preferred finishing material.)

Finishing Tropical Hardwood

The best oil-based finishes on the market today start with polymerized tung oil and then have additional enhancements such as natural colorants, UV protectants, and fungicides, resulting in a final product that is a low-VOC, marine-grade finish. Premium-quality transparent iron-oxide pigments are used because they are more stable than dyes and provide excellent UV protection. High-quality UV blockers, similar to those used in automotive finishes, are also added to the mix in order to maximally protect the wood from color fade.

A fungicide can be added to help prevent fungi or mold from growing on the wood. This type of finish is competitively priced on a square-foot basis since it covers about twice as much as other lower-quality wood finishes, approximately 600–800 square feet per gallon for hardwood and 250–300 square feet per gallon for softwood. Many companies overdilute their product with solvent, bringing down the price point and subsequently lowering the potential coverage of the product. Higher-quality products will have a high oil-to-solvent ratio, resulting in better coverage. These new coatings are designed to be applied in one coat, and they have been shown to last longer than other transparent finishes.

When it is time to refresh the finish, as long as no significant discoloration or graying of the wood has occurred, minimal sanding or pressure washing is required—just a general cleaning of the surface to remove any dirt, dust, pollen, etc. Of course, the manufacturer's instructions should be followed in all cases.

Exterior Hardwood Finishes

The two most common wood finishes are film-forming and penetrating oil finishes. Although the finishes may look similar on wood at first, they differ vastly in breathability, longevity, and upkeep.

Film-Forming Finish: A film-forming finish creates a coating or film on top of the wood surface. This coating helps protect the wood by reducing the effects of weathering. This finish can be painted or sprayed on and needs to be stripped and reapplied at the first sign of bubbling or cracking. Since the finish does not penetrate the wood, the natural occurrence of expansion and contraction will create cracks in the film and eventual peeling. The cracks and peeled finish expose the unprotected wood to moisture and sunlight, causing advanced deterioration. Hence, film-forming finishes are commonly used on interior furniture, away from the elements, and are not recommended for use on exterior tropical hardwood.

Exterior Hardwood Finishes

Polyurethane Finish: A polyurethane finish (sprayed or brushed on) is commonly used on cabinets and furniture. Inside a building, these types of finishes can last longer because there is not a high variability of moisture, and therefore the wood is not moving as much. Polyurethane finishes should never be used on exterior decks, wood siding, or exterior furniture.

Marine-Spar Varnish: Sailors have historically needed something to protect their boats while allowing for the natural flexing of wood exposed to sun, salt, and water. Oil and resin were added to a solvent to create a flexible varnish that can expand and contract. Although developed with the aquatic life in mind, marine-spar varnishes only create a barrier between the wood and the water. Many marine-spar varnishes on the market today act like plastic wrap that needs to be frequently reapplied to prevent peeling. Marine-spar varnishes can be a useful tool in aquatic applications if selected, applied, and maintained properly.

Exterior Hardwood Finishes

Penetrating Oil Wood Stain: Penetrating oil wood stain is a type of finish that absorbs into the wood and does not fail as often or as quickly as film-forming finishes because it allows the wood to move. This type of stain is typically the best for exterior furniture and outdoor decks because it does not peel or flake off over time. Even a high-quality penetrating oil will eventually gray out and weather over time. A regular maintenance schedule is required.

Traditional pure tung oil for use in interior applications is very different. Pure tung oil requires a multiple-step application process that can be quite time consuming. Each layer needs between two and three days to harden, and a regular protective coating requires five to seven coats. Pure tung oil needs to be reapplied repeatedly to ensure a lasting finish and should not be used in exterior applications with exposure to weather. However, premium exterior wood stains that incorporate tung oil are typically polymerized so the dry and hardening times are accelerated.

Care is needed, though, since overapplying a penetrating oil-based finish can cause a film to form over the wood, which has more potential to peel, flake, and unevenly fade over time. It's important to remember that more is not always better. The most common issues faced when applying oil-based finishes are typically the result of overapplication or application over an incompatible finish already on the wood.

Exterior Hardwood Finishes

Premium-Quality Pure Tung Oil Stain: The most advanced penetrating oil wood stain available uses pure tung oil as its base. Additional components are added to prevent any fungal or mildew growth, protect from UV rays, and provide other enhancements. This type of oil stain provides superior protection for exterior wood applications, such as decking, siding, and outdoor furniture. It is guaranteed by the manufacturer to look good for at least two years, at which point a simple recoating is all that is needed, with minimal sanding or pressure washing required.

A high-quality tung oil blend for finishing tropical hardwoods has been tested and found to provide the best results for preserving the character and visual appeal of the wood. For example, the tigerwood outdoor dining table shown here is fully exposed to the weather year-round on a south-facing deck in Portland; it was finished 22 months before this picture was taken and has had only two light maintenance coats since then.





Review

Explain why resilient hidden decking and siding fasteners are preferred for use with tropical hardwood.



Answer

Hardwoods must be predrilled before screwing—the best hidden fastener systems do not require predrilling.

Hidden clip fasteners are nylon 6/6 reinforced with 13–15% glass fibers, providing extra durability, tensile strength, and flexibility that will complement the expansion and contraction of tropical hardwood boards.

Typical hardwood boards can swell up to 3/16" in width. The clip will compress to absorb this expansion. When the wood later dries out, the hidden fastener spring clip will move the boards back into place, centered perfectly and securely fastened.



Sustainable Wood for Exteriors

Average Carbon Footprint in U.S. and Canada

A 2019 article by Hannah Ritchie titled “Where in the World Do People Emit the Most CO₂?” notes that in the United States, the carbon footprint per capita is 16.2 tons per year, and in Canada, the carbon footprint per capita is 15.6 tons per year.

A major benefit of using real wood products is that wood actually removes carbon from the environment and almost always has a negative carbon footprint even after milling and shipping is accounted for.

In comparison, cement, plastics, and metals all require large amounts of fossil fuels to manufacture, which creates a large carbon footprint.

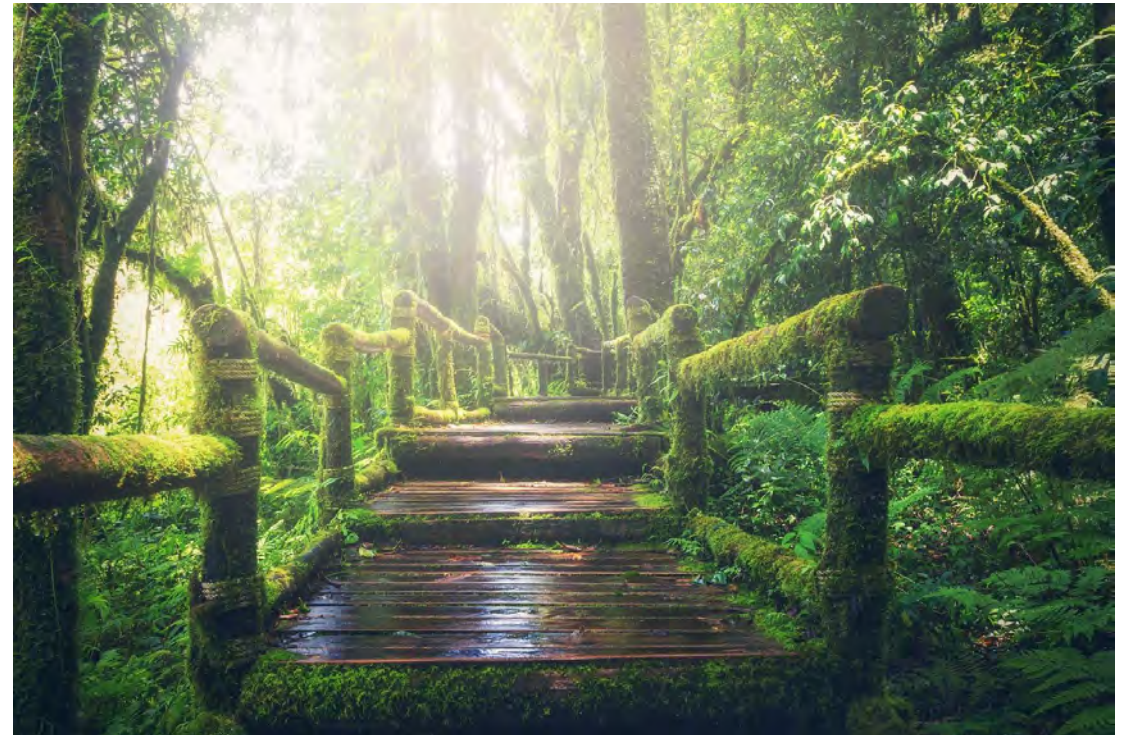


Carbon Storage in Trees

One of the major benefits trees provide to our environment is that they remove carbon from the atmosphere, storing it within the wood, which helps reduce climate change.

Carbon is one of the most abundant elements on our planet. Carbon has the tendency to be attracted to oxygen, which in turn forms carbon dioxide or carbon monoxide, both of which are considered pollutants when in high concentrations.

Trees remove carbon dioxide from the environment through photosynthesis. When photosynthesis occurs, trees convert the carbon from carbon dioxide to a solid sugar form, which is stored in all parts of the tree and assists with tree growth. Once the tree has converted the carbon, it releases the oxygen back into the environment.

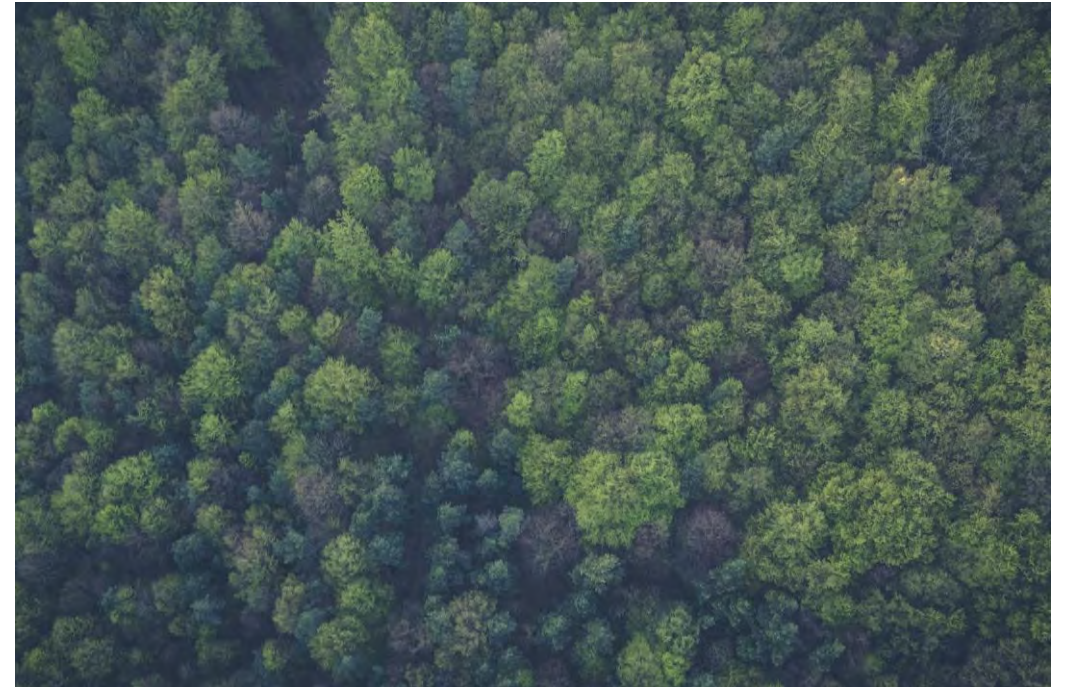


Carbon Storage in Lumber Products

Carbon makes up approximately 50% of the dry mass of any given tree; trees on average are 65% dry mass.

When trees are used for lumber, the carbon remains in the wood for the lifetime of the wood product. Carbon is released from the lumber back into the environment only after the wood begins to decay or when it is burned.

For most tropical hardwood products, this means that the carbon will be stored for approximately 40+ years within the product, therefore keeping it out of the atmosphere for the same amount of time.

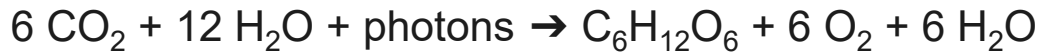


When this information is coupled with the way properly managed sustainable forests operate, the argument can be made that natural wood products have a much smaller carbon footprint than most composite materials and man-made building materials.

Source: Leys, Andrea J. "How Is carbon Stored in Trees and Wood Products?" Forest and Wood Products Australia, n.d.

Calculations for Carbon Storage in Trees and Lumber

Chemical Formula for Photosynthesis:



(carbon dioxide + water + light energy → glucose + oxygen + water)

To determine the equivalent amount of carbon dioxide sequestered in each tree, the carbon figure is multiplied by a factor of 3.67.

CO_2 sequestered per tree (kg) = Tree mass (kg of fresh biomass) x 65% (dry mass) x 50% (carbon %) x 3.67 x 120%

CO_2 sequestered in lumber (kg) = Air-dried mass of the boards (kg) x 85% (oven-dried mass) x 50% (carbon %) x 3.67

Source: Leys, Andrea J. "How Is carbon Stored in Trees and Wood Products?" Forest and Wood Products Australia, n.d.

Calculation for One Shipping Container of Red Balau

Lumber Mass (kg) = Volume of lumber (m³) x density of wood (kg/m³)

Density of red balau = 850 kg/m³

Gross CO₂ sequestered in one container of red balau =

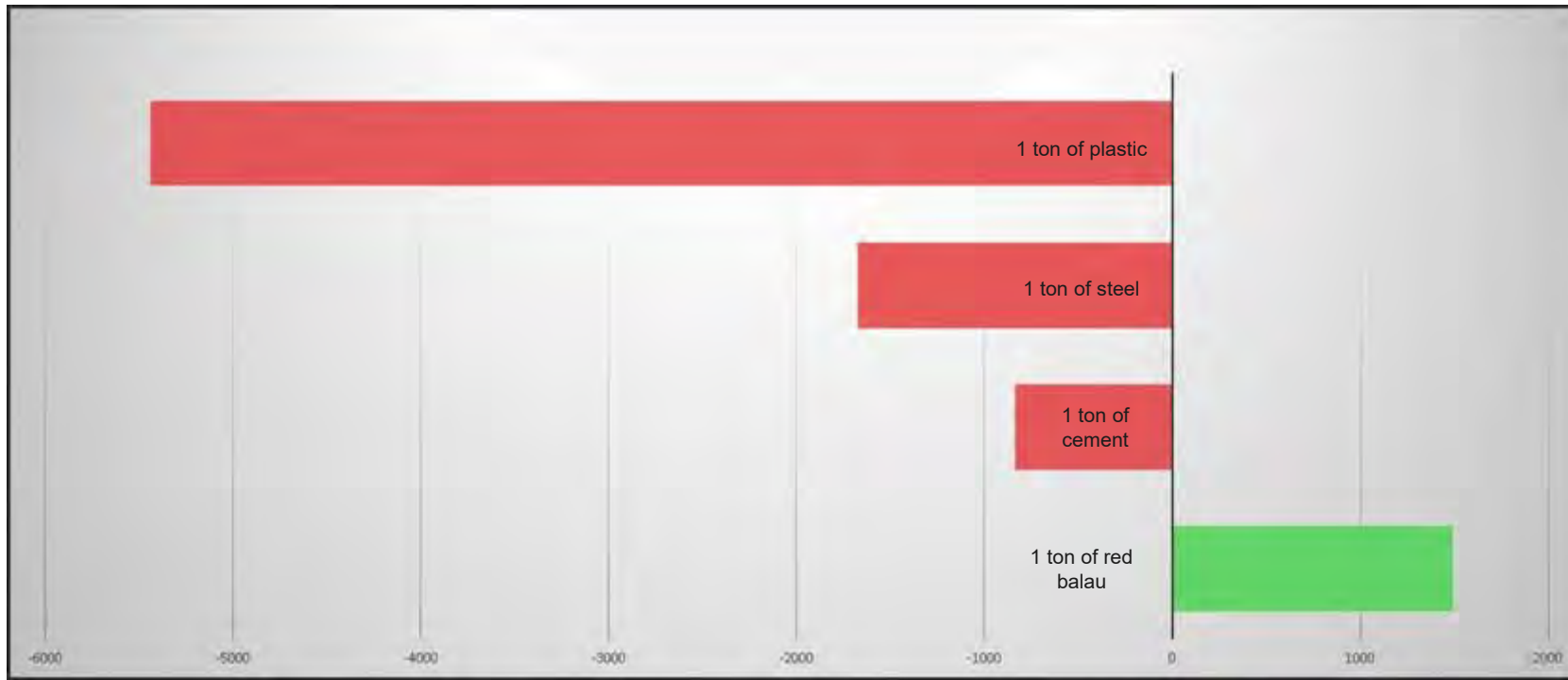
25 m³ = 21,250 kg of dry mass x 85% x 50% x 3.67 = 33,144 kg or 36.53 tons of CO₂ stored per container of red balau.

CO₂ emitted shipping one 20-ton container from Southeast Asia to the East Coast of the U.S. is approximately 3,200 kg or 3.52 tons.

Net CO₂ sequestered in one container of red balau = 29,944 kg or 33 tons.

Source: Leys, Andrea J. "How Is carbon Stored in Trees and Wood Products?" Forest and Wood Products Australia, n.d.

CO₂ Emissions Comparison of Building Materials



1 ton of plastic = 5,442 kg of CO₂ emitted on average (depends on the type of plastic)

1 ton of steel = 1,677 kg of CO₂ emitted

1 ton of cement = 840 kg of CO₂ emitted

1 ton of red balau = 1,497 kg of CO₂ **removed** from the environment

Source: Leys, Andrea J. "How Is carbon Stored in Trees and Wood Products?" Forest and Wood Products Australia, n.d.

Sustainable Wood for Exteriors

Wood has been widely recognized as a renewable, natural material that has less embodied energy than other building materials. Embodied energy is defined as the amount of energy that a product requires from the point of extracting the raw material, through its processing or manufacture and its final transportation to a construction site.

This so-called cradle-to-gate analysis of wood clearly shows that less energy is required to harvest, process, and transport wood products than is required for heavier, more energy-intensive building products, such as steel or concrete. Hence, wood is deemed to have less embodied energy as a product.



Sustainable Wood for Exteriors

Recently, wood composite materials have been developed in response to reduced quality wood availability. These products have been presented as an alternative to solid wood products by combining wood fibers with synthetic fibers and resins. Wood composite materials have been touted as environmentally friendly since they can be made from recycled content.

However, the correct recycled plastics can be difficult to source and sort, which often leads companies to resort to using newly created plastic to create a wood composite. If a company manages to find a recycled plastic source, it often includes petroleum-based plastics in its mix. In fact, there are many solid plastic PVC products containing no wood fiber at all. Most of these PVC and composite products are not recyclable, eventually creating even more plastic waste. These products have a much higher embodied energy content than wood, reducing their environmental sustainability.

Further, the structural support systems for PVC and composite decking and cladding must be carefully designed and constructed since they are not as strong as wood. Most notably, the plastic content makes these products expand and contract, especially in length, due to thermal conditions, whereas wood has a negligible amount of thermal movement.



Legality and Sustainability of Tropical Hardwood

Legality and Sustainability of Tropical Hardwood

Architects need to properly specify the type of wood for projects on our clients' behalf, and therefore we need to reference reliable third-party sources who focus in these areas. When dealing with wood that comes from international sources, there are specification criteria that can be referenced. First is to ensure that it is being legally imported. This point is discussed next.

U.S. Lacey Act: In the year 1900, the United States government recognized a need to prevent the trafficking of illegal wildlife and related items into this country. This recognition led Congress and President McKinley to sign into law the Lacey Act. In 2008, that law was amended to include plants and plant products, encompassing timber, wood products, and paper. This was a landmark move, making the United States the first country in the world to ban trade in illegally sourced wood and plant products. This is now the minimum requirement that all wood imported into the United States must meet to be considered a legal import. As a result, and in compliance with the Lacey Act, a statement in architectural specifications needs to indicate that all wood from non-U.S. sources is legally imported.

U.S. Lacey Act

The U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) is the agency charged with enforcing this law. It works with other organizations, such as the U.S. Fish and Wildlife Service and CITES, to focus on two aspects of the law. First is the legality requirement. This means that any wood imported into the United States must have met all the laws that exist in the country of origin of that wood. For example, if a particular country bans the cutting of wood in a particular area or of a particular type, it is deemed illegal and rejected from entry into the United States. Ignorance of the laws of those countries is not a defense, and the requirement applies regardless of who did not comply (i.e., the importer, the exporter, the sawmill, the forester, or any other party). The second focus is on proper documentation for wood imports. This involves filing paperwork with APHIS that declares information about the wood, including the scientific name (genus, species), the value of the wood, the quantity in a shipment, and the country of origin where the wood was harvested.

The United States has a long history of effectively enforcing the Lacey Act. Penalties can be severe and include forfeiture of the shipment, significant fines, and even jail time for violators. The law recognizes different levels of violation as well as a standard of reasonable due care. This means companies or organizations involved in professions or industries directly related to wood imports are reasonably expected to know how to comply with all relevant laws. Those tangentially involved, such as shipping companies, can still be implicated but are not necessarily held to the same standard of due care.

Legal Wood per ASTM and LEED®

As a means to help the building industry with a resource to identify legal wood, there is a credit in the LEED Materials and Resources category, “Building Product Disclosure and Optimization—Sourcing of Raw Materials, Option 3: Multi-Attribute Assessment of Products: Use products that meet at least one of the criteria below. Each product can receive credit for each criterion met. The scope of any environmental product declaration (EPD) must be at least cradle to gate.” One of the criteria under this option is wood products: “Wood products must be certified by the Forest Stewardship Council® or USGBC-approved equivalent.”

There is also the “Pilot Alternative Compliance Path—Legal Wood,” which was released by LEED v4 as “a means to test LEED’s ability to address illegal wood in the building industry.” This pilot credit relies on ASTM Standard D7612-10, “Standard Practice for Categorizing Wood and Wood-Based Products According to Their Fiber Sources,” as an objective basis to differentiate among 1) noncontroversial (i.e., legal) sources of forest products; 2) responsible sources of forest products (i.e., noncontroversial sources together with certified procurement systems or from forests managed using responsible practices); and 3) certified sources of forest products (i.e., noncontroversial sources together with a certified chain of custody).



Legal Wood per ASTM and LEED®

According to ASTM, the purpose of this standard and practice is “to provide wood products manufacturers, distributors, and retailers with a system to provide clear, objective information to communicate to consumers regarding product conformance to different wood-fiber tracing systems within specific forest management or certification programs. It provides a structure that segregates the different types of labels and tracing systems in use among major forest certification standards and other voluntary and regulatory standards governing the production of forest products.”

Under the LEED Legal Wood pilot credit (which is focused on legality more than sustainability), two of the three referenced categories are needed to meet the credit requirements. First, 100 percent of all wood is verified to be from legal sources as defined by ASTM D7612-10. These components include, at a minimum, structural framing and general dimensional framing, flooring, subflooring, doors, and finishes. Second, 70 percent of all wood (based on cost) used on the project is from responsible sources as defined by ASTM D7612-10. These components include, at a minimum, structural framing and general dimensional framing, flooring, subflooring, doors, and finishes.

SVLK (Sistem Verifikasi Legalitas Kayu)

Some countries undertake their own programs to regulate and certify that wood being exported from their country is legal. A good example is the Sistem Verifikasi Legalitas Kayu (SVLK) certification, which is Indonesia's national timber legality assurance system.

In order for any wood to be exported, this mandatory certification attests to its legality and can also indicate its sustainability, all based on a national multistakeholder consensus system. Since a good deal of batu hardwood is imported from Indonesia, this certification is important for that species.



Please remember the **password TROPICAL**. You will need it to proceed with the online test.



Review

Recall and describe the different finishing options for tropical hardwood.



Answer

Film-Forming Finish: A film-forming finish creates a coating or film on top of the wood surface. This coating helps protect the wood by reducing the effects of weathering. Both polyurethane and varnish are film forming—and they should not be used outside.

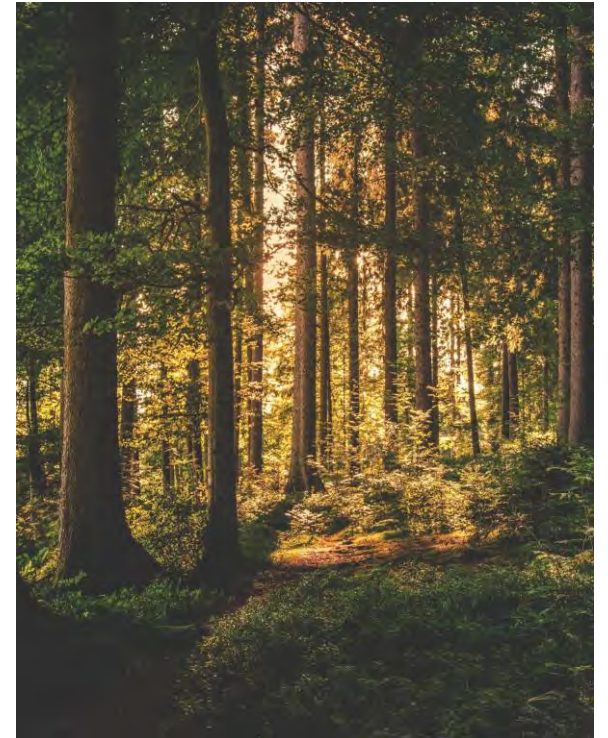
Penetrating Oil Wood Stain: This is a type of finish that absorbs into the wood and does not fail as often or as quickly as film-forming finishes because it allows the wood to move. This type of stain is typically the best for exterior applications because it does not peel or flake off over time. Linseed and tung oil are both penetrating oils.

Sustainable Wood

Beyond legality, there are separate, independent organizations that look to higher standards of sustainability for wood. These organizations have typically identified three main criteria. The first is to source wood that comes from an actively managed forest that uses sustainable practices, such as selective harvesting, natural regeneration, and minimal-impact logging methods. The second is documentation to identify the type of wood and trees that are being harvested and the precise locations where they were cut. Third is an established procedure to document a chain of custody that tracks harvested trees on their journey to a mill, through distribution, and ultimately to a construction site.

All these are important because it means there is independent, verifiable information that the wood used in a building comes from legitimate and sustainable sources rather than poorly managed or clear-cut forests. All this is directly relevant to the environment because actively managed forests sequester more carbon dioxide and help reduce the amount of greenhouse gases in the atmosphere. Ideally, we need to increase the overall footprint of well-managed, sustainable forests not just for wood sourcing but also for the health of the planet.

Some of the organizations involved in sustainable wood are summarized next.



The Forest Stewardship Council® (FSC®)

The Forest Stewardship Council (FSC) is probably the best-known reference for sustainable forest management, wood harvesting, and delivery of wood products. In part, this is because it is the only organization that has been recognized by the U.S. Green Building Council for LEED certification.

This has not been without some controversy since there are other organizations that provide similar functions and are more common in certain parts of the world. Nonetheless, it is common to specify wood that is FSC certified and request chain-of-custody documentation indicating that the wood delivered to a project site has indeed been tracked all the way back to a certified, sustainably managed forest.

This has worked well for softwood lumber in the United States and Canada, but since FSC has a smaller presence in places such as South America and especially in Southeast Asia, it should not be the only organization considered for tropical hardwood certification—it simply may not be available in certain parts of the world. It has been observed that the vast majority of LEED-certified projects have not pursued the credit for certified wood for any number of unknown reasons. Hence, not having FSC certification available may not be a deterrent in achieving LEED certification.

The Sustainable Forestry Initiative® (SFI®)

The Sustainable Forestry Initiative (SFI) Inc. is also a well-known and recognized organization that operates in the United States and Canada.

It offers standards that are updated periodically on the three main areas of sustainable wood products: forest management, fiber sourcing, and chain of custody.

In addition, it provides rules and guidance on how SFI product labels should be used and procedures for identifying the products in written materials.



PEFC (Programme for the Endorsement of Forest Certification)

Lesser known in the United States, the PEFC (Programme for the Endorsement of Forest Certification) is an international, nonprofit, nongovernmental organization dedicated to promoting sustainable forest management through independent third-party certification.

According to its website, “with 44 endorsed national certification systems and over 300 million hectares of certified forests, PEFC is the world’s largest forest certification system.” Unlike some other organizations, it works much more with small, nonindustrial private forests, with more than 19,800 companies currently holding PEFC chain-of-custody certification.

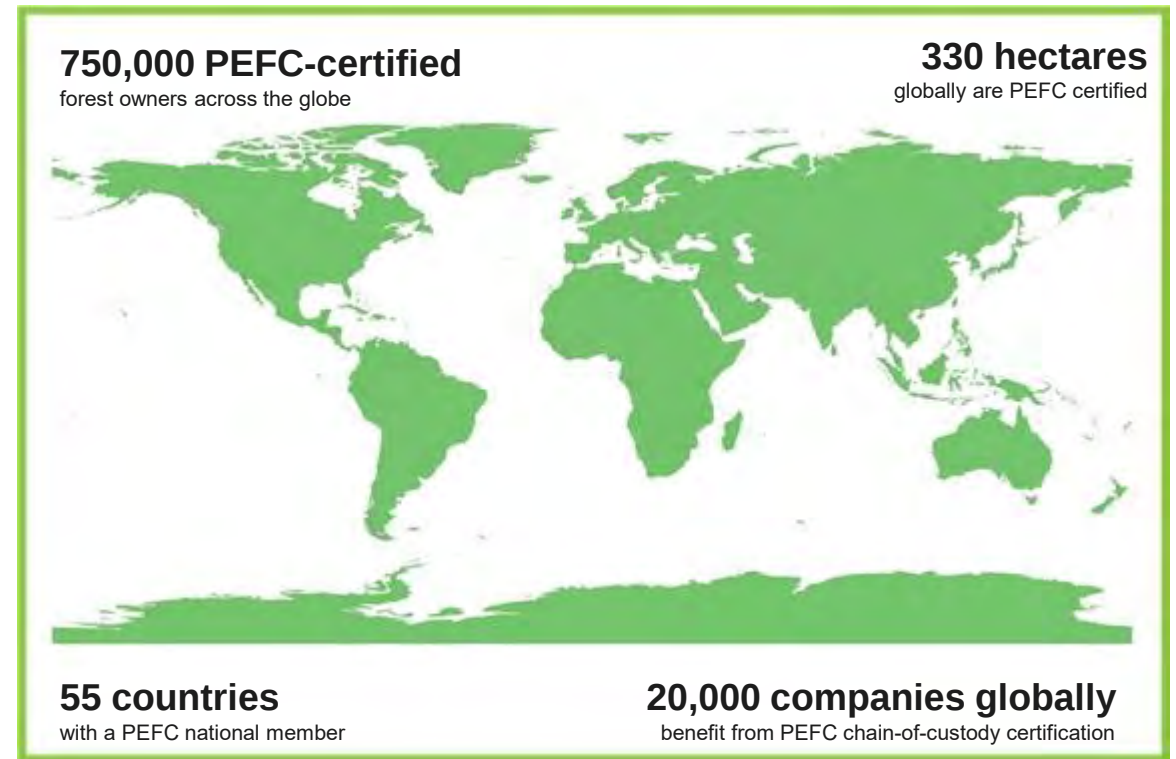
The organization also points out that it “works throughout the entire forest supply chain to promote good practice in the forest and to ensure that timber and nontimber forest products are produced with respect for the highest ecological, social, and ethical standards.” It provides an eco-label that is earned, so customers and consumers are able to identify products from sustainably managed forests.



PEFC

Further, it acts as an umbrella organization for national forest certification systems in dozens of countries. In order to be certified under PEFC, each national forest certification system is subjected to rigorous third-party assessments to show compliance with PEFC Sustainability Benchmarks, thus ensuring it meets international sustainability requirements.

When designing with and specifying tropical hardwood, it is important to recognize that while there are standards that are used solely for North American wood products, there are also different standards available that can and should be referenced. This is true whether the building project is pursuing LEED certification or not, particularly since the international standards are more relevant and may even be more stringent.

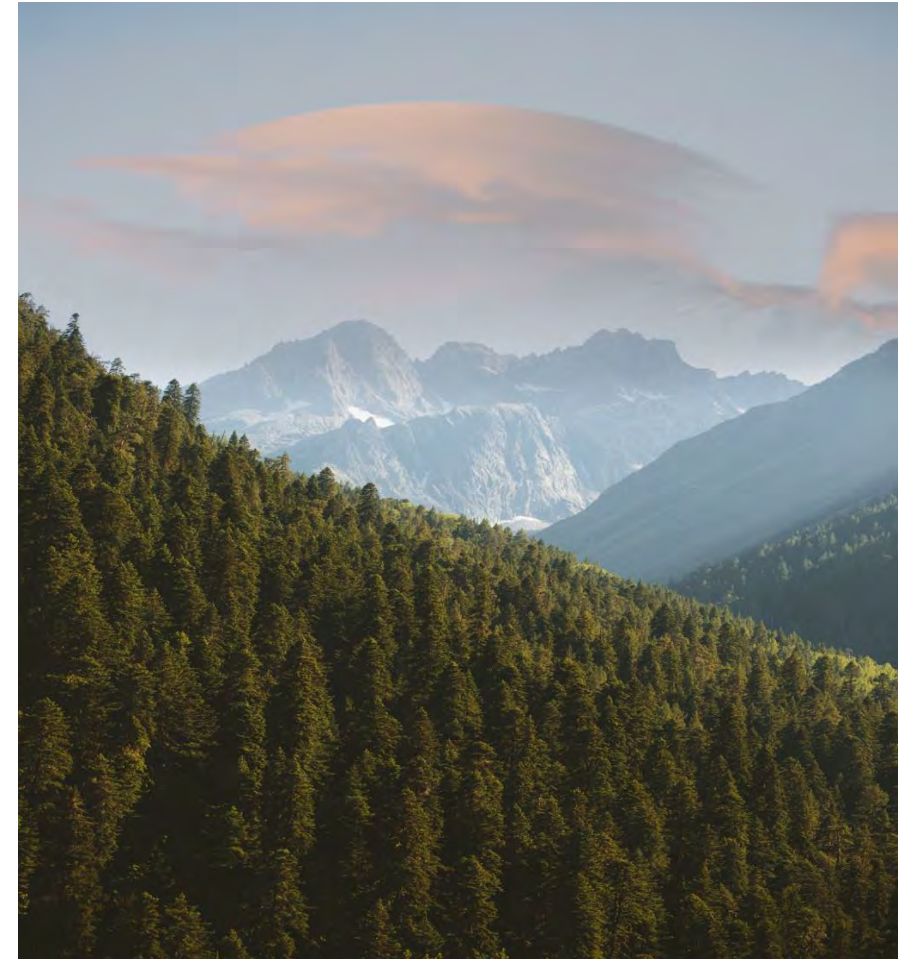


The Circular Bioeconomy

An article titled “The Circular Bioeconomy,” published by CIFOR (Center for International Forestry Research), discusses the concept of a circular bioeconomy—an economy that is powered by nature. This economic model promotes the extended life span, reuse, and sustainability of naturally sourced products. An emphasis is placed on reducing waste and replacing a wide array of nonrenewable and fossil-based products currently in use.

Forests are critical in the development of circular bioeconomy systems as they are the main nonfood and nonfeed renewable natural resource. Wood is also the most versatile renewable resource, making forests a key factor in enabling a circular bioeconomy to work successfully.

There are multiple considerations to be made when it comes to the implementation of a circular bioeconomy. Some of these include landscape diversification, local needs, and rural/urban flows.





Review

Name three organizations that are involved in the certification of sustainable wood.



Answer

- FSC: Forest Stewardship Council
- SFI: Sustainable Forestry Initiative
 - PEFC: Programme for the Endorsement of Forest Certification



Summary

Summary

Wood is a very desirable and sustainable building product. However, as concerns are raised over the use and availability of certain species, new ones are being sought out and increasingly used for projects of all types around the world.

Architects seeking the natural appearance of wood for exteriors, coupled with long-term durability, are turning to many options in tropical hardwoods that are sourced and certified as sustainable by a variety of credible, independent organizations. In the process, they are creating appealing, sustainable, and durable buildings that their clients will enjoy for many years to come.

Resources

“The Circular Bioeconomy: Knowledge Guide.” Center for International Forestry Research, 2021, https://www.cifor.org/wp-content/uploads/2021/03/Flyer%20-%20Knowledge%20Guide_Circular%20Bioeconomy-v4.pdf. Accessed Nov. 2022.

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