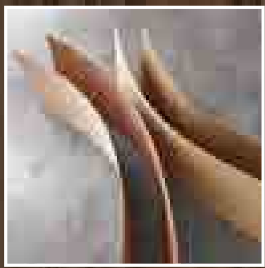
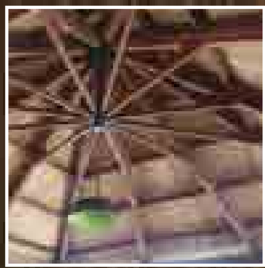
VOLUME 1

USER GUIDE

FOR ECO-CERTIFIED AFRICAN TIMBER

IN EUROPE

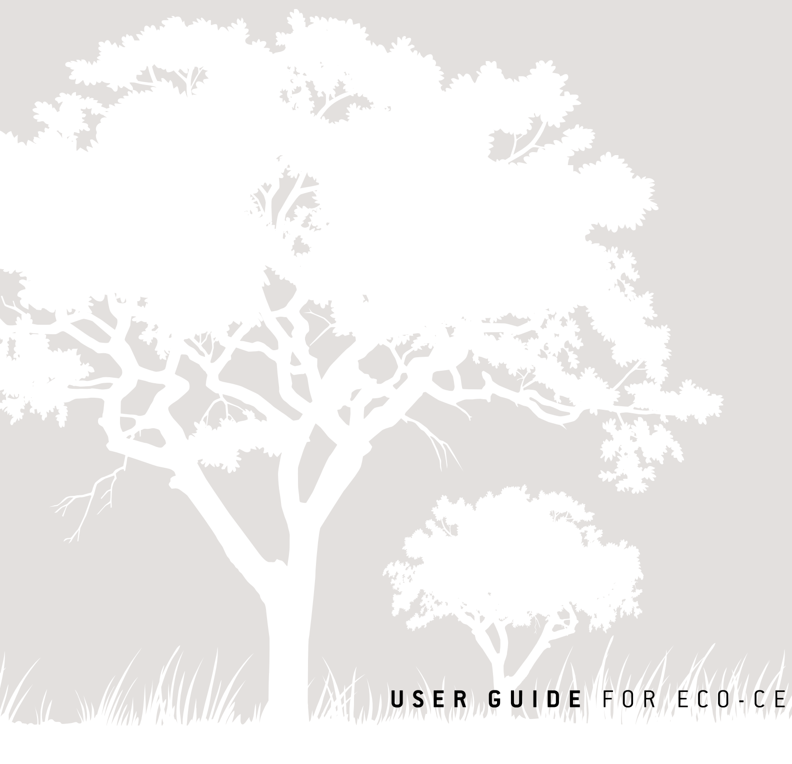
PATRICK MARTIN
MICHEL VERNAY

atibt
THE LEADING AUTHORITY ON TROPICAL TIMBER

INTRODUCTION

Forest eco-certifications are now recognised by many stakeholders as a tool for economic, social and cultural development, for the preservation of biodiversity and for the fight against deforestation. Several regulatory provisions have been implemented in recent years to support this approach: national sustainable development policies, public procurement policies, the EU Timber Regulation (EUTR*), etc. Despite this, the perception that certified African timber products are efficient and responsible materials remains a minority view, and consumers - who are insufficiently informed - are often dubious of this or don't really feel concerned.

For this reason, several players of the sector, represented by the ATIBT (*Association Technique Internationale des Bois Tropicaux* - International Technical Association of Tropical Timber), have initiated marketing actions in favour of certified African tropical timber, so that the public can more easily learn about and identify the various species. The "User guide for eco-certified African timber" which is presented here is part of this effort to generate awareness among European consumers. It has received financial backing from the PPECF (*Programme de Promotion de l'Exploitation Certifiée des Forêts* - Programme for the Promotion of Certified Forest Operations) and the AFD (*Agence Française de Développement* - French Development Agency), which should both be thanked heartily.



Volume 1 of this guide for the use of certified African timber is intended for European users of African timber, as well as all suppliers, distributors, designers, public prescribers and instructors whose activities are linked to the timber sector. (Volume 2 will be considered for African consumers.) This guide is a tool that promotes certified African species in Europe, whose uses complement those of temperate timber species. Its objective is to provide - in the first section - technical information on the various aspects of tropical timber, highlighting the benefits that it provides when used in construction. In the second section, we will present a range of works where tropical timber has undoubtedly proven to be the best solution and we will offer a list of species enabling these works to be achieved. In order to obtain the best possible results, the use and the implementation of timber must be done according to each work's standard processes, which determine how well the timber will perform. The qualitative aspect of the timber must also be respected in order to successfully complete projects.

The authors
Patrick Martin, timber engineer (ENSTIB*), doctor of timber sciences (ENGREF*), technical director at ATIBT*.
Michel Vernay, timber engineer at CTFT* and then at CIRAD*.
Both are noted experts serving the sector for the development of timber in construction.

We would like to thank each person and company that has provided us with the photos used in this guide, especially **Daniel Guibal** from CIRAD*, for the species illustrations, and the people who have enriched this guide through their proofreading, in particular **Christine Le Paire**, communications manager at ATIBT*.
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Words marked with an asterisk (*) are defined in the glossary at the end of this guide.

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CONTEXT AND ISSUES

TROPICAL FORESTS: VALUE THAT CANNOT BE REPLACED

Photo 1: Evergreen forest © JL. Doucet, NATURE+

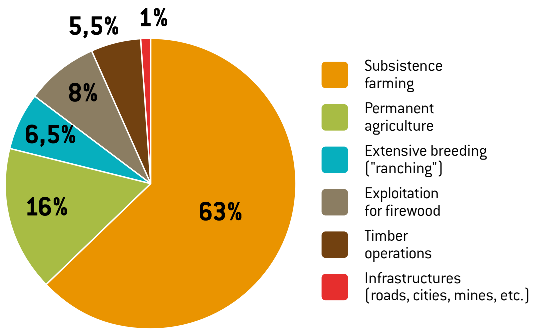
Today's dramatic global population growth is accompanied by a growing quest for resources that is worrisome in terms of our forests. Trees and their timber are a source of profit, but once it has been deforested, the land space they occupy also represents potential agricultural profits that can lead to greed. Beginning in the 1970s, a few environmental organisations that were aware of this threat strove to ensure that citizens, governments and businesses learned of the irreplaceable value of tropical forests. This awareness of the tropical forest cause was absolutely necessary and unavoidable.

PROMOTING TIMBER IN ORDER TO PRESERVE TROPICAL FORESTS

Unfortunately, media coverage has been indiscriminate and often to the detriment of logging companies whose production is legal, sustainable and certified. In fact, this amalgamation has had the effect of devaluing tropical timber and has overshadowed the real risks that forests face. Moreover, if local populations are unable to derive sufficient income from logging, they will necessarily have to seek alternative sources of income. In this case, the only way they will be able to survive is through the development of breeding, cash crops (coffee, cocoa, livestock, etc.) and slash-and-burn agriculture* (manioc, bananas, peanuts, etc.), which will enable them to meet their needs. Some States also encourage their inhabitants and companies to carry out this conversion in order to meet the subsistence needs of their population or as a result of an economic development policy (ex: oil palm cultivation in Malaysia, grasslands for breeding and sugar cane cultivation in Brazil, etc.). It is imperative that this phenomenon be stopped, otherwise tropical forests will irrevocably be converted into farmlands and ranch lands.

The preservation of tropical forests therefore requires a rational valuation of its main product: timber. This remarkable material, regularly renewed by forests, is predestined to carry sustainable value.

According to the FAO (2002), these are the global deforestation and forest degradation factors:



(Source : FAO, 2002)

A MODERATE REMOVAL COMPARABLE TO A "HARVEST".

This chart clearly shows that the phenomenon of deforestation cannot be solely attributed to logging. Trees that have genuine value, commercially speaking, are in fact highly scattered throughout the forest and represent only about 100 of the 50,000 species that tropical forests are filled with. Moreover, this value depends on their diameter, their conformation* and their accessibility. As a result, tropical forests do not lend themselves to large-scale logging (as is the case in North America where the total number of species is limited to about 10), but to a moderate removal that is comparable to a “harvest”.

SUSTAINABLE MANAGEMENT AND CERTIFICATION: THE FUTURE OF FORESTS

Conscientious forestry companies whose production is both legal and sustainable wanted to remove themselves from the irresponsible image that the media associates them with. To this end, they have fully committed to a CSR* approach over thirty years ago that takes into account both major environmental criteria and respect for the local populations and communities that live in these forests. Several of them have chosen to adopt a certification system: FSC* or PEFC*, by having their activities audited by third parties. This approach includes powerful traceability tools that enable the verification of timber, by the end customer as well, at any time during its transformation, transport or use. The idea here is not to present all of the principles of forest certification, but here are three important examples:

- **Development plan and reasoned harvesting of trees:** when it is set up, the forest concession is divided into about 30 parcels according to a development plan. Each year, the company only intervenes on a single plot to extract no more than two trees per hectare (which amounts to one tree per football field). The next passage in this same plot will only take place 30 years later, according to an annual rotation system between the plots. During this period, the forest is at rest, so that it can regenerate naturally;
- **Wildlife protection:** the forestry companies have hired forest guards and game wardens to protect animals from poaching. This explains why more elephants and gorillas are often found in concessions than in so-called “protected” reserves;
- **Socio-economic development at the local level:** certified forestry companies directly and indirectly create local jobs in Central Africa, and they construct many infrastructures in the vicinity of the workplace such as wells, roads, housing, schools, dispensaries, etc.

The contribution of this approach is therefore quite real and today, nearly 5.5 million hectares of the Congo Basin are certified. Unfortunately, the public is largely unaware of the concrete actions taken in the field. Today, the sector’s players are coming together to publicise their actions in favour of tropical forests (especially in the Congo Basin). They plan on communicating regularly with the media and the general public in order to shed some truth and to combat conventional wisdom. It is essential to show that forestry companies who are committed to sustainable management comply with the most stringent environmental standards and spend large sums of money to be audited by independent bodies. Certified companies are determined to become the benchmark for tropical forests in terms of Social, Environmental and Economic Responsibility.

The European authorities have also become aware of the stakes, and have contributed greatly to this development in recent years, thanks to their implementation of FLEGT* and EUTR* legislation. As a result, the importation of illegal timber has become totally marginal in Europe. Other major countries such as the United States, Japan and Australia have also set up regulatory tools to achieve this goal.

Thus, this guide for the use of certified African timber demonstrates that by choosing the certified timber that is most appropriate for its intended use, the consumer contributes to preserving a sustainable and economically viable farming system while limiting product waste and ensuring an optimal lifetime according to his or her usage. In addition to the satisfaction derived from an exceptional material, the user also contributes to the preservation of a protected ecosystem that includes its fauna, its flora, its populations and its cultures.

PART 1

TIMBER AND ITS CHARACTERISTICS

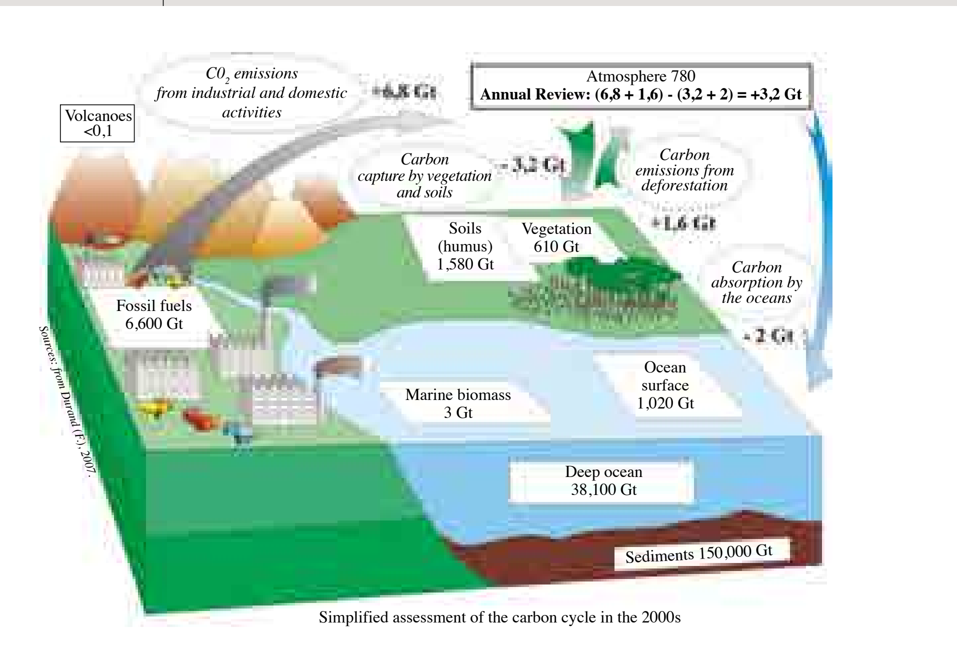
1. TIMBER, AN ENVIRONMENTALLY FRIENDLY MATERIAL

THE CARBON CYCLE

Carbon is an essential element present in all forms of life on the planet. In fact, it’s the main link that constitutes the structure of all organic molecules. As every form of life is by definition mortal, carbon “travels” in different forms. All of the exchanges between these various forms are referred to as the “carbon cycle”.
Note: GT is the abbreviation for gigaton. 1 GT equals one billion tons.
The carbon emissions and absorptions shown in this diagram represent the balance of exchanges. For example, each year the vegetation captures about 60 GT of carbon by photosynthesis, while its degradation (respiration, dead trees, fires, deforestation, etc.) releases 1.6 GT more carbon into the atmosphere.
In the atmosphere, carbon essentially exists in the form of carbon dioxide: CO_2. The quantity of this gas in the air is measured in ppmv (parts per million by volume).
Note: 1 ppmv equals 1 cm^3 of CO_2 contained in 1 m^3 of air

POLLUTION AND GREENHOUSE EFFECT

Through their various activities, humans have been modifying the balance that nature has put into place a long time ago. Thus, the rate of CO_2 in the atmosphere, which was 270 ppmv before 1800, rose to 300 ppmv in 1900 and reached 400 ppmv in April 2014. This rate increases by about 7 ppmv per year.
Deforestation and the extraction of fossil carbonaceous compounds (such as coal, oil, gas, etc.) are the two causes of this phenomenon.



Simplified assessment of the carbon cycle in the 2000s

Photo 2: Carbon cycle © F. Durand

Carbon dioxide plays two harmful roles on our planet if it is present in too great a quantity:
it is toxic to the animal kingdom
it contributes to climate change through the greenhouse effect
Adverse effects on health are felt at a rate of 1,500 ppmv of CO_2 in the air, with the appearance of headaches and dizziness. Precautions are taken in cities in terms of traffic to reduce CO_2 emissions that are detrimental to the population's health. In addition to the harmful effects it has on the animal kingdom, the carbon dioxide contained in the atmosphere has a negative effect on solar energy, causing global warming according to the greenhouse effect principle.
Although global warming amounts to a few degrees depending on which specialist is consulted, we're observing climate changes that are more pronounced in certain regions (milder winters, storms, increasingly frequent floods, etc.). This phenomenon was scientifically recognised in 1992, during the Rio conference.

THE TREE AS A CO_2 CONSUMER

The production of timber in trees results from photosynthesis. CO_2 from the air is essential for the development of plants. This process makes it possible to synthesise organic matter, mainly carbohydrates, from the carbon dioxide captured in the air using sunlight and water drawn from the soil. This is followed by a series of molecular transformations leading to the transformation of carbohydrates into cellulose, an essential component of timber. The simplified global assessment of this synthesis is that trees consume water, carbon dioxide and minerals to produce timber while releasing oxygen.

TIMBER, A MATERIAL THAT STORES CARBON

50% of timber's mass consists of carbon. The formation of timber can be summarised in a very simplified manner by: Carbon dioxide + Water ➔ Wood + Oxygen.
In order to put things in perspective and understand the consequences of this CO_2 consumption on the atmosphere, here are two illustrations:

- To produce one kilogram of timber, a tree must consume all of the CO_2 contained in 2,600 m^3 of air. (2,600 m^3 represents the average volume occupied by a building housing 40 people).
- When the forest produces 1 m^3 of timber, it purifies a volume that is equivalent to the air polluted by an airplane carrying 600 people over a distance of 2,500 km.

N.B. If a tree is not exploited, it will eventually die and fall. The timber left in the forest will be degraded by biological organisms and the CO_2 captured throughout its life will return to the atmosphere. Thus, a forest left in its natural state no longer stores carbon when it is mature.
Note: vegetation represents a renewed carbon stock (610 GT), just like all timber constructions and objects. As long as carbon is stored in timber, it is not present as CO_2 in the atmosphere.
This phenomenon is often misunderstood by people. It is essential that we exploit the timber of a forest if we want to maintain the beneficial effects it produces on the atmosphere. These effects are especially important if timber replaces petroleum products as a material or fuel, and even metals and minerals.

A transformation that requires low energy consumption

In addition to capturing CO_2, the timber's transformation is both ecological and economical. This material requires a small amount of energy to be produced, and the same is true of its transport, its implementation and recycling. By way of comparison, it requires ten times less energy than steel.
Its use therefore makes it possible to reduce our overall energy consumption, thereby attenuating the air pollution produced by fossil energies.
When taking into account the CO_2 captured in the atmosphere when it is created, timber is also the only material whose production and implementation leaves a negative balance of CO_2 production in the atmosphere.

2. TIMBER DESIGNATION

Each tree bears a Latin name that is attributed by botanists on the basis of criteria relating to the tree's leaves, flowers or fruits, but not the characteristics of the timber it produces. The differences and similarities between these criteria made it possible to establish hierarchical tree structures called classifications.

N.B.: The name of a tree is defined by its genus, its species and the name of the botanist who described it. Example: *Entandrophragma cylindricum*, Sprague, for Sapelli.

Schematically, the trees are divided into two main categories: Gymnosperms, also known as Conifers, which produce wood referred to as "Resinous", and Angiosperms. The latter are divided into two sub-categories: the former encompasses the Monocotyledons, whose most impressive representatives are palm-trees and bamboos, and the second contains all of the so-called Dicotyledonous plants. It is the Dicotyledonous trees that produce timber referred to as "hardwood"; this group includes almost all of the African timber that is exported.

Trees that have a few essential characteristics in common in terms of the organisation of their flowers and fruits are grouped into families. Within a family, trees with many common criteria are grouped by genus. And within each genus, one or more species are distinguished. For example, the *Meliaceae* family includes, among others, the *Khaya*, *Entandrophragma* and *Lovoa* genera. Within the *Khaya* genus, marketed under the name of Acajou d'Afrique, the *anthotheca* and *ivorensis* species are differentiated.

PLEASE NOTE: The characteristics of timber depend on the structure of the cells and how they are arranged. Most of the time, the botanical species (the tree) is a guarantee of the properties expected by users.

On a practical level, a user chooses a wood for its physical, mechanical or aesthetic properties, which must be as homogeneous as possible. The use of the botanical name could be a good solution for such a purpose, however, it is possible that within a same species, the timber originating from the tree has characteristics that vary according to the environmental data associated with its place of growth (soil characteristics, amount of sunshine, water, silviculture, etc.). Moreover, the botanical name is not always easy to remember, and in the field, the woodcutter or the person carrying out the forest inventory can barely identify the species with certainty. Other criteria, such as density or colour, can therefore be taken into account to reduce this variability. Example: Limba, also known as Fraké, has two categories of timber that are differentiated by appearance: white or multicoloured. Just the same, several species of the same genus or of different genera can produce timber whose characteristics are very similar. Basing one's choice using the botanical name as the sole criterion is therefore no longer sufficient to guarantee the expected homogeneity.

For this reason, timber has always been marketed using species names or pilot names, which can include several genera and several species. For example, the Aniégré commercial

FAMILY	MELIACEAE					
GENUS	KHAYA	ENTANDROPHRAGMA				LOVOA
SPECIES	anthotheca ivorensis	candollei	cylindricum	utile	angolense congoense	trichilioïdes
TRADE NAME	ACAJOU D'AFRIQUE	KOSIPO	SAPELLI	SIPO	TIAMA	DIBETOU

species includes several species from two different genera: *Pouteria* and *Chrysophyllum*. Cases where one pilot name includes all species from the same botanical genus from a single continent are very rare. Just the same, certain botanical species are present on several continents and carry a different pilot name; for example the *Symphonia globulifera* is called Ossol in Africa and Manil in South America.

PLEASE NOTE: To indicate the presence of several species grouped under a single botanical genus name, the "spp." abbreviation (meaning species *pluralis*) was created. Beware, though, as "several" does not mean "all", and some species not cited in the example can be very different from the species at hand. This also applies to temperate species; for example, European oak may be designated by *Quercus spp.* (*Quercus robur, Quercus petraea, etc.*), a group in which it would not be acceptable to include green oak (*Quercus ilex*) or cork oak (*Quercus suber*). Another example: the *Bubinga*, *Mutenyé* and *Ovéngkol* species are all different but they come from several species of the same botanical genus: *Guibourtia*.

A PILOT NAME TO AVOID CONFUSION

The name of a species is relayed by the populations of a country, sometimes even a region, in the form of common names, known as "vernacular" or even "commercial" names locally. It is not uncommon that depending on the origin of the timber, a single vernacular name may refer to different species. One can cite the "ironwood" name, attributed to species from different continents, whose density and hardness resemble that of iron (Azobé, Ebène, Gaïac, Agoho, Ipê, Wamara, Panacoco, Morado, etc.).

These different names constitute a risk of confusion in commercial trade. It was for this reason that in 1950 ATIBT established a designation of tropical timber, defining each species with a unique, internationally recognised pilot name for all of the botanical species that it includes.

A regular updating of the Designation is necessary to introduce and remove certain species according to their frequency on the market, but also due to the evolution of certain botanical names. Example: the *Monopetalanthus* genus, of which some species were associated with the Andoung trade name, was split into two new genera: *Aphanocalyx* and *Bikinia*.

The benefit of this designation was clearly understood by the French Ministry of the Economy, Finance and Industry, which recognises ATIBT* - in a circular dated 5 April 2005 - as the "gatekeeper" of tropical timber designation.

This pilot name is the result of a choice dictated by practical considerations that consist in retaining the usual name in which the timber is most marketed, adopted either by the main exporting country or by the main importing country. The determination of the pilot name of a species is crucial, because its commercialisation is highly dependent on the adoption of this name by the commercial world. Its protection makes it possible to guarantee the consistency of the species' properties.

Another solution to simplify the designations without any risk of confusion would be to use the code consisting of several letters defined in European standard EN 13556. As with the ATIBT designation, this registration of species defines the genera and species that feature an expected set of properties. For example, the Azobé (Lophira spp., L.alata, L.procera) is identified by LOAL. Unfortunately, there are still too few species of African origin.

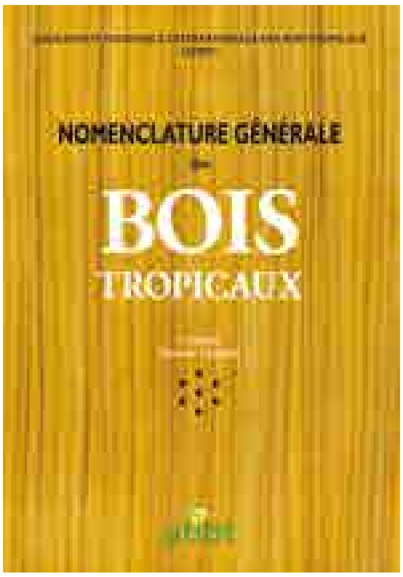


Photo 3: Nomenclature © P. Martin, ATIBT

3. PROPERTIES AND CONDITIONS OF USE

Tropical forests shelter a remarkable biodiversity, resulting from an environment that favours both mutation and natural selection. As a result, we find trees whose timber has exceptionally varied properties that naturally meet - without modification or treatment - all of the usage criteria recommended for works carried out in tropical environments and, even more so for works carried out in Europe. It is also, thanks to their remarkable properties, that tropical species have conquered the European markets. The benefits of these tropical species are numerous: mechanical strength, durability*, aesthetics, machinability, stability, immensity of supply, etc. These species are suitable for a wide range of uses and are a natural complement to temperate species. By choosing timber that is adapted to its intended use, the user will remain confident in his approach for future projects.

3.1. MECHANICAL RESISTANCE

The design of timber structures is carried out using the calculation codes and the known mechanical properties of timber. Since timber is not isotropic*, the parameters that qualify this material are quite numerous. To simplify its characterisation in the laboratory, it is possible to measure its three main properties (density, resistance and elasticity modulus in flexion) in order to obtain its assignment to a mechanical class. As soon as the mechanical class is identified, the other mechanical properties (tensile strength, compression, flexion bending, elasticity modulus...) are arbitrarily defined according to the EN 338 standard. Timber's mechanical properties are highly dependent on its singularities*.

For each species, the visual classification of sawn timber defines its quality and guarantees its associated mechanical properties. The EN 1912 standard lists several national standards in Europe which describe the various visual classification rules for structural uses.

PLEASE NOTE: The mechanical class is essential to obtain the CE marking of structural timber.

3.2. HARDNESS

The hardness of timber is measured according to several indices: Monnin, Janka, Chalais-Meudon, Brinell, etc. Monnin hardness is the one most often used to characterise the hardness of timber. It is measured by the depth of the impression left by a cylindrical shape on which a given force is applied (cylinder with a 30 mm diameter and longer than 20 mm with an applied force of 1,960 newtons).

The Janka test measures the force required to drive a metal ball into the timber to the midpoint of its diameter. The value indicates the pressure required to make the ball penetrate: the higher the value, the harder the timber. Chalais-Meudon flank hardness expresses the resistance that timber displays against the penetration of a hard body. The number (which lacks a unit of measurement) that characterises it is equal to the inverse of the arrow of penetration of the generator of a steel cylinder that is stamped under a load of 1,000 N per centimetre of test tube width.

Brinell hardness is measured by the depth of the impression left by a ball with a 23 mm diameter, ballasted for a mass of 1 kg, dropped from a height of 50 cm. This test makes it possible to measure the hardness of the timber and its resistance to indentation*. Brinell hardness is expressed in N/mm. The hardnesses are ordered into four classes: A (soft), B (semi-hard), C (hard) and D (very hard).

In the specific case of floorboards, for each use defined by the intensity of passage and the nature of the activity, there is a minimum required hardness. These usage classes are identified by a two-digit number; the first one represents the nature of the activity: 2 (domestic), 3 (commercial) and 4 (industrial); and the second one represents the traffic intensity: 1 (moderate), 2 (general), 3 (high) and 4 (very high). Example: an airport waiting room is classified as 33 (commercial use and high traffic), so the floor can be made using:
- Iroko, Makoré, Moabi, Movingui... with a minimum wear layer of 4.5 mm,
- Doussié, Wengé... with a minimum wear layer of 3.2 mm.

3.3. RESILIENCE

The resilience coefficient measures timber's resistance to impact bending (Joule/cm^2). It is proportional to the total rupture work. The test is carried out with a shock.

3.4. AESTHETICS

The beauty of a timber is subjective. Tropical species cover a wide range of colours, including intense colours (red, yellow and black) unknown among European species. The organisation of the various fabrics that make up this material, as well as certain singularities*, can provide it with highly sought-after aesthetic qualities that contribute to the reputation of certain tropical timbers in sectors such as furniture, carpentry, cabinetmaking and decoration.

Photo 4: Various colours of African timber © M. Vernay

Photo 5: Wengé© M. Vernay

For a majority of tree species, the chemical molecules naturally synthesised during the growth of each tree gives the timber its colour. Sapwood*, the part of the timber in which these molecules are not yet stored, is therefore often differentiated from heartwood* in terms of its colour. Note: the absence of these molecules means that the durability* of sapwood* against biological degradation agents is always low.
When these molecules are uniformly distributed across the timber's cells, the colour is relatively homogeneous. However, in some species, the cells can be specifically coloured depending on their function. Wengé is a good example: it features clear strips of parenchyma that alternate with dark strips of fibre.
In other species, colour irregularities may appear in larger areas. When they appear as veins, for example in Afrormosia, Bubinga, Awoura, or Zingana, they are generally appreciated. These irregularities can result from a growth defect, which is either due to the blocking of the tree's metabolism at a

Photo 6: Greying of timber © M. Vernay

certain period of its life and in certain precise zones of the trunk, or to external aggressions via the tree's reaction. In this case, irregular colours can be considered to be a defect. In some very specific species, defects appear as discoloured or over-coloured areas and appear only on a few trees or areas of the tree. This type of phenomenon is not related to a geographical area. In addition to the aesthetic disorders caused by this anomaly, these duraminization* disruptions can weaken durability* locally; however, the mechanical characteristics are not affected.
These abnormal colorations can take several forms:

- one-time spot (Lati, Iroko)
- timber discoloration (Sapelli, Moabi, Makoré)
- black vein (Movingui)
- light spot (Padouk)

Similarly, certain species (Azobé, Nieuk, etc.) may feature an intermediate zone between the sapwood* and the heartwood*, referred to as transition wood. This imperfectly duraminized* zone is lighter than perfect wood.
In the event of a disturbance occurring during the growth of the tree, the duraminization* process can temporarily stop and subsequently resume, thereby enclosing non-duraminized timber zones that are referred to as internal sapwood*.
When used and implemented, the colour of timber evolves. In general, the pigmented molecules of timber react to light and the colours fade over time, becoming duller. However, some finishes are able to slow down discoloration.
Another phenomenon results from the combined action of ultraviolet rays and water, which also causes aging and a loss of colour on the surface of the timber; the timber becomes grey: this phenomenon is simply referred to as "greying".
In both cases, discoloration only affects the surface cells, and a simple sanding or chemical stripping makes it possible to largely recover the timber's original appearance.
The size and organisation of the cells that make up the timber give the material a specific appearance. The timber's anatomy is thus at the origin of the various figures* that are visible in decorative timber. For example, a Sapelli which has layers of timber whose fibres have an alternating orientation, and which feature right and left propellers that produce a "ribboned timber". These figures* are obtained in normal timber.
In the area where the first branches are formed, known as the "fork", the wood strands are deflected and produce the irregular shape sought after for veneering. In this zone, coloured "reaction wood" can also be formed.
When timber singularities* (defects) result in a particular aspect in some cuts, it is known as "figured wood".
Numerous designations are distinguished:

- Timber is "figured" or "grainy" when the timber strands are entangled. This entanglement can either be due to a disruption in the cambial area, to the succession of buds that suddenly abort, or to the presence of a fungus that disrupts the tree's growth. These anomalies can appear in the burrs, brambles or bushes.

Other strand irregularities are distinguished:
- "Rippled" woods result from curves that are very close to the strands, revealing areas where the strands alternate regularly (Makoré, Avodiré, Movingui, etc.).
- "Wavy" woods are characterised by small strips that are perpendicular to the tree's axis, in which the strands alternate regularly.
- "Draped" woods have "S" shaped areas in which the strands are uniformly tilted.
- "Dappled" or "quilted" woods are characterised by elevated areas giving the impression of rounded bumps.

A few industrial techniques have been developed to reproduce highly varied representations of tropical species from tinted, glued and entrenched Ayous veneers. This technique is also applied to timber with a temperate origin, such as poplars.

Photo 7: Reconstituted veneers © ALPI

3.5. DURABILITY

3.5.1. DEGRADATION AGENTS

Fungi are the primary timber degradation agents. Their development requires a sufficient supply of water and oxygen and a favourable temperature. There are different categories of fungi: lignicolous* and lignivorous*. The latter can cause degradation such as white rot*, soft rot* and cubical rot*. In the latter type, dry rot fungus is a fungus known for its virulence. It is responsible for many disasters in Europe.

In some geographical areas, termites pose as serious a threat to timber as do fungi attacks. Termites live in an organised society (with a queen, soldiers, workers, etc.), just like bees and ants. They need woody material to feed themselves and they take advantage of the material to protect themselves from predators and light (which they constantly fear outside of the swarming period). To move about in the open, they build galleries with sawdust, saliva and excrement. Certain woods are less easily attackable due to their hardness, the presence of certain chemical compounds or their silica content. A prior attack by a fungus can allow termites to settle and degrade any wood. All sapwood* can easily be altered by termites. In Europe, common species belong to two types of termites: Kalotermes (so-called "dry wood" termites) and Reticulitermes (so-called "subterranean" termites) present in the Mediterranean perimeter, in Spain and in south-western France. Contrary to popular belief, these species are endemic and were not imported with tropical timber. Although they are called "inferior" termites, they have a less elaborate digestive system and they remain very prolific. Subterranean termites, which have relatively high water requirements, do not establish their colony in the wood, but in the soil or in an environment with sufficient water supply. Dry wood termite colonies settle directly in the wood. Although they can be more easily eradicated, their detection is often difficult.

In addition to termites, xylophagous* insects - in their larval state - mainly attack dry wood. Dry wood is primarily attacked by bark beetles and lyctus beetles. Damage leaves a worm-eaten appearance with galleries of different sizes.

As for immersed wood, it is safe from insects and fungi. However, in saline or brackish waters, the environment is conducive to several wood degrading biological agents. Molluscs and crustaceans are found in this environment. Among the molluscs, pholadidae are small mussels which form galleries that are a few centimetres wide. Tares cause much more damage. They take on the form of soft and fragile white worms and they dig cylindrical galleries (about one centimetre in diameter over several metres in length), which they carpet with a limestone wall. Hard wood species with high silica content or that are rich in repellents have a high degree of resistance against marine borers and can be used in class 5 structures according to the biological risk exposure standard.

3.5.2. NATURAL DURABILITY

Durability is a property that is intrinsic to each species: it represents its ongoing ability to resist against attacks by biological degradation agents: fungi, insects with xylophagous* larvae, termites, marine borers*, etc.
Note: there is no such thing as non-biodegradable* wood. If a species had this property, the forest would be a huge pile of dead and non-degraded wood lasting several thousand years. All wood degrades at different speeds depending on the conditions in which they are found. To evaluate this property, laboratory tests have been carried out on different species according to a standard protocol (EN 350). The results were validated and confirmed by real-world feedback. The most frequently used durability classes are those related to lignivorous* fungi.
Note: tests are carried out on duraminized

5 levels are noted:

DURABILITY CLASS	DESCRIPTION
1	Highly durable
2	Durable
3	Moderately durable
4	Slightly durable
5	Non-durable

wood. When referring to the durability of the wood, only heartwood* is taken into account, because sapwood* is never durable.
Durabilities are presented according to standard EN 350, (see appendix 1), with:

- Durability against fungi: from 1 (highly durable) to 5 (non-durable)
- Durability against xylophagous larvae: from S (sensitive) to D (durable)
- Durability against termites: from S (sensitive) to D (durable)
- Durability against marine borers*: from S (sensitive) to D (durable)
- Impregnability*: from 1 (impregnable) to 4 (non-impregnable)
- The width of the sapwood: from tf (<2 cm) to l (> 10 cm)

Not all species are included in this standard, but it is possible to find the information in the technical data sheets published by the CIRAD* or in the TROPIX* software application.
Note: durability values in relation to termites are obtained from tests that involve placing hungry termites in contact with wood. This "you eat or you die" principle excludes the notion of appetence, that is to say termites' attraction or preference for the choice of their location of installation.

3.5.3. USAGE CLASSES

Usage classes describe the intensities of exposure to the various biological risks. They are defined in the EN 335 standard.
Note: For a long time, they were referred to as "risk classes" in France (but this designation was abandoned because it sounded too negative).

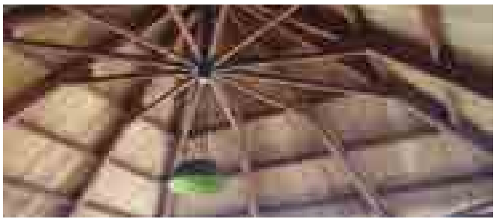
The usage classes do not define the expected lifetime. For example, a stake made of low-durability timber, designed to support a plant, can be used in a class 4 usage situation (direct contact with the soil) for a 1-year lifetime. If a lifetime exceeding one year is desired for this same situation, this species is not suitable.

Usage class 1:

Situations in which the timber is sheltered, completely protected from bad weather and not exposed to humidification.
Examples: wooden floors, furniture, panelling, etc.
Photo 8: Furniture © F. Codron, PELTIER BOIS

Usage class 2:

Situations in which the timber is sheltered, fully protected from bad weather, but where high ambient humidification may lead to occasional non-persistent humidification.
Examples: frameworks, roofing elements, etc.
Photo 9: Truss frame © P. Martin, ATIBT

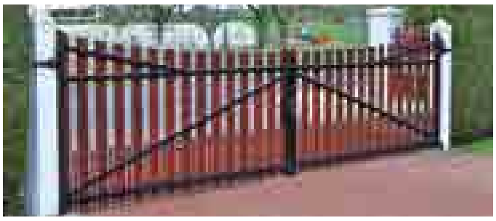


Usage class 3.1:

Situations in which the timber is unprotected, without ground contact, and continuously exposed to bad weather, or sheltered but subject to frequent humidification.
Examples: carpentry, outer coating (partially sheltered), etc.
Photo 10: Exterior door © F. Codron, PELTIER BOIS

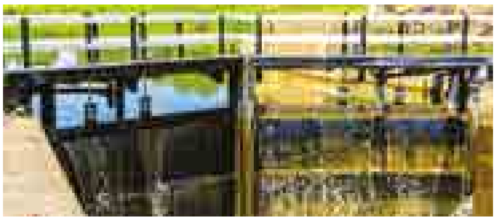
Usage class 3.2:

Class 3A situations, but with longer humidification times.
Examples: joinery, outer coating (exposed to bad weather), etc.
Photo 11: Exterior gate © M. Vernay



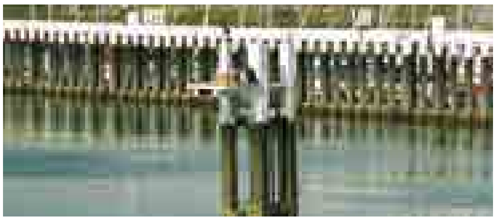
Usage class 4:

Situations in which the timber is in contact with the ground or fresh water, and is thus permanently exposed to humidification.
Examples: fences, poles, terraces, etc.
Photo 12: Lock © Imfoto



Usage class 5:

Situations in which the timber is in constant contact with salt water or brackish water.
Examples: jetties, pontoons, etc.
Photo 13: Water shielding © G. Scherrer



PLEASE NOTE: The ascending numbering of the usage classes is consistent with the environment's humidity. Usage class 5 is applicable to submerged marine environments only. Timber that naturally covers usage class 5 does not systematically cover the lower usage classes.

PLEASE NOTE: Commercially speaking, the usage class is incorrectly used as a durability performance indicator, without taking into account the expected lifetime. This error stems from standards that are specific to the chemical treatment of timber (see § 3.6 Timber treatment).

3.5.4. THE RIGHT TIMBER IN THE RIGHT PLACE

In practice, these usage class definitions remain difficult to grasp; for example the expression "exposed to bad weather" is a highly variable notion depending on whether one is referring to a place where precipitation is frequent or not. It is possible to narrow down this perception with documentation booklet FD P 20-651, where the following parameters are taken into account:

- the climate in which the structure is located (dry, moderate or humid[1]);
- local conditions (coastal zone, valley bottom without sunlight, proximity to a source of humidity generating recurrent periods of mist or fog, etc);
- type of design (conditions under which rainwater is drained and desorbed*);
- massiveness (the more massive timber is, the lower its desorption* capacity);
- exposure to the prevailing rain wind.

When the usage class is correctly defined, the choice of timber can be made according to the expected lifetime of the structure.

L3	Longevity exceeding 100 years
L2	Longevity between 50 - 100 years in the originally intended use
L1	Longevity between 10 - 50 years in the originally intended use
N	Longevity less than 10 years in all cases (solutions not recommended for buildings)

According to these principles, timber that is highly resistant to fungi (durability class 1) can be used with an acceptable lifetime, even in an environment that is highly favourable to biological degradation agents. Conversely, for usage class 1, it is possible to use timber with low durability, including durability class 5. One must also keep in mind the risk of degradation caused by xylophagous* larval insects and termites.

1 - The three geographical zones are defined by the annual number of days where precipitation is greater than 1 mm (dry: under 100 days; moderate: under 150 days; humid: over 150 days)

3.6. TIMBER TREATMENT

3.6.1. WHY TREAT TIMBER?

The treatment of timber aims to improve its durability* performances when it is insufficient for a targeted use; in this case, it is referred to as **preventive** treatment. This is not essential if the expected lifetime is low (ex: a stake or post made of low-durability wood). It is also possible to get rid of the degradation agents that timber may contain; this is referred to as **curative** treatment.
The performance of the processes depends on the timber's impregnability* as well as the technique, material and possibly the product that is used. There are different types of treatments: chemical, thermal or a combination of both.

3.6.2. CHEMICAL TREATMENTS

In general, the formulation of a chemical is made using active biocidal* substances, molecules that will apply these active substances to the timber and a solvent (petroleum or water), which makes it possible to spread all of it throughout the timber before it evaporates. The active ingredients can be mineral substances (metal salts) or synthetic substances that are more or less complex. Several molecules have been developed using those found in wood in its natural state: tannins, acids, terpenes, phenolic compounds, etc. The great difficulty lies in how to get them to penetrate into the wood and remain there. This task is much easier for a tree whose metabolism produces these molecules as it grows.
The active ingredients used target one or more timber degradation agents: lignivorous* fungi, insects with xylophagous* larvae, termites, etc. A combination of these active ingredients may be necessary to cover a wider field of action.
The application of the chemical product is carried out using various techniques:

- Painting (brush)
- Spraying (nozzle)
- Soaking (tray)
- Vacuum/pressure (autoclave*)

Photo 14: Autoclave© P. Filius, ARCH TIMBER PROTECTION LTD

Treatment using an autoclave* enables the treatment product to be applied more effectively, but the final result will depend on:

- the timber's impregnability*
- the timber's initial humidity level
- the chemical used
- the pressures that are applied
- the duration of the treatment cycles

PLEASE NOTE: "Treatment at the core" is a misnomer because, in the majority of cases, the treatment product does not penetrate the entire mass of the timber, but it does so peripherally at a variable depth. The commercial name "autoclaved* wood" therefore applies to products of various conferred durabilities. Commercially, the performance of treated timber is displayed by professionals via a usage class, as required by current standards. Example: "class 4 treated" timber is timber with durability conferred for usage class 4 (with a guarantee varying between just 3 - 5 years). This incorrect designation creates confusion among users (see § 3.5 durability).

N.B.: Standards require that the person performing the treatment be able to provide a **certificate of treatment**. This certificate is a declarative commitment describing the treatment process, the product's characteristics and the penetration and retention values. It may be checked retrospectively as part of a conformity check.

As of 1 June 2007, the REACH* regulation (Registration, Evaluation, Authorization and restrictions of CHemicals) restricts the use of biocidal products* through maximum concentrations that are authorised in timber, in order to take into account adverse effects on humans and the environment.

In particular, supervisory bodies aim to limit the following undesirable elements:

- Pentachlorophenol (PCP)
- Polychlorinated biphenyls (PCBs)
- Carbendazim, chlorothalonil, etc.
- Heavy metals: lead, cadmium, mercury, etc.
- Substances subject to the restrictions in annex XVII of REACH* (consisting of creosote, arsenic, chromium, cadmium, as well as boron and its derivatives).

In particular, timber that has a green colour may be subject to searches for traces of a treatment based on copper salts (CCA: Copper Chrome Arsenic, CCB: Copper Chromium Boron), organic copper or oxyquinoline copper. Note: This green colour is sometimes found in new formulations, it is actually a dye intended to remind consumers of the image of the effectiveness of products that are currently banned in Europe.

REACH* regulations requires chemists to develop new solutions that are less biocidal*. But these solutions must also meet the needs of users who expect effective - that is to say more biocidal* - products. Industries that manufacture such products must demonstrate their effectiveness. Given the lack of feedback from the field, these evaluations are limited to laboratory tests, the results of which are often debatable.

Chemical treatments can provide timber that has low natural durability or lesser value with greater durability. However, this conferred durability never reaches the level that is inherent in timber with the highest natural durability (examples: Bilinga, Doussié, Mukulungu, Padouk, Tali, etc.). Moreover, any machining subsequent to a treatment exposes a zone of wood whose durability is lower than that expected, and no process can restore its initial level of protection in the field.

3.6.3. TREATMENT WITH CREOSOTE

Creosote is a commonly used product reserved exclusively for a specific use: the preservation of railway sleepers and utility poles. It differs from other chemicals in two aspects. On the one hand, the active substances are a set of very large molecules resulting from the distillation of coal (between 100°C - 500°C). On the other hand, its application doesn't require any solvents and all the product introduced will permanently remain in the treated timber throughout the required service life.
Note: The effectiveness of creosote is mainly due to the formation of toxic molecules, some of which are highly carcinogenic (soluble phenols and benzo-a-pyrene in particular). Treatments with creosote are regulated.

3.6.4. TREATMENT WITH ISMP/NIMP 15

The ISPM/NIMP (International Standards for Phytosanitary Measures) standard is established by the IPPC (International Plant Protection Convention), in connection with the FAO (Food and Agriculture Organization of the United Nations). This standard provides measures to limit the risk of the occurrence and spread of harmful organisms in timber packaging.
The treatment involves heating the timber at a minimum core temperature of 56°C for at least 30 minutes. These conditions are lethal to insects in all their forms (eggs, larva*, nymphs*, imagos*). Drying of the timber using an artificial dryer (KD - kiln dried, see § 3.7 timber moisture) enables such treatment. The standard recognises this process provided that the prescribed target moisture values are met. This is a curative treatment without any guarantees over time (non-preventive). Fumigation is another technique that meets this requirement.

3.6.5. TREATMENT WITH FUMIGATION

Fumigation is a timber treatment that uses toxic gases: methyl bromide, hydrogen cyanide, hydrogen phosphide, ethylene oxide, carbon dioxide, etc. In some European countries, this operation must be carried out by a company that is approved by a competent authority (usually a ministry).

3.6.6. THERMAL TREATMENT

The principle of this treatment consists in placing the timber in an enclosure under a controlled atmosphere (after prior drying), with inert gases (mainly nitrogen) lacking oxygen to avoid combustion of the material. The temperature is then gradually increased to a maximum of between 180°C - 250°C. The treatment modifies the timber's most hydrophilic* constituents. The timber is then cooled to room temperature. The treatment's total duration varies between 10 - 25 hours depending on the timber species, its thickness and the type of process used.
With this type of treatment, cellulose molecules, starch and various sugars, which are the main foodstuffs of rot fungi, are degraded. Moisture resumption is also greatly reduced and dimensional variations (shrinkage-warp) are significantly attenuated. The development of lignivorous* or lignicolous* fungi is thus no longer possible. Timber treated with this process is recognisable by its homogeneous brown colour and its burning smell.

Note: Durability is all the more enhanced as the molecules are degraded.
During this degradation, density, hardness and mechanical properties are reduced, which sometimes allows for the infestation of nesting insects (carpenter bees, etc.). The presence of singularities* favours the appearance of deformations and cracks. Timber free from defects and with straight thread is generally preferred.
Controlling the homogeneity of timber's density is a fundamental factor. Combining various species in the oven is excluded because the duration of the treatment must be established with precision (an excessive long treatment duration mechanically degrades the wood, and a duration that is too short prevents expected durability performances from being achieved).

It should be noted that the gluing and application of finishes are difficult to achieve on thermally treated timber. The degradation of wood cells no longer enables external molecules to be properly attached, especially those associated with water because the timber has become hydrophobic*.

3.6.7. TREATMENT WITH ACETYLATION

Acetylation consists of the substitution of active hydrogen atoms (free hydroxyl groups) with acetyl groups. Acetic anhydride is commonly used as an acetylating agent.
Timber's reaction to acetic anhydride is an exothermic* process. The timber's temperature must be controlled in order to avoid thermal alteration. The reaction produces acetic acid as a by-product, which must be extracted at the end of the treatment. Acetylation is a slow process that can be accelerated through the use of a solvent and/or a catalyst.
The species that can be treated with acetylation must demonstrate good impregnability*. Low density (and low natural durability) species, such as radiata pine, lend themselves more readily to acetylation. This timber treatment is only effective throughout the mass for low thicknesses and reconstituted woods.
Products treated with acetylation were introduced into the European market less than a decade ago. The stability of acetyl groups when faced with temperature variations, UV rays and mechanical stress (water erosion, indentation, etc.) must still be demonstrated in order to define a realistic usage lifetime.

3.6.8. TREATMENT WITH FURFURYLATION

Furfurylation is a technique that involves impregnating timber with a furfuryl alcohol solution that is then polymerised on the cells' walls. Furfuryl alcohol is a derivative obtained from the bran (furfur in Latin) of many cereals. The furfuryl alcohol molecules settle in the timber under acidic pH conditions and at a temperature that is between 100°C - 150°C. Under these conditions, the lignin and cellulose, which will receive the polymer, will degrade. The furfurylated timber subsequently becomes hydrophobic* and more durable with respect to biological degradation agents. This treatment simultaneously generates a 0% - 125% increase in density, which is accompanied by enhanced hardness and mechanical properties, as well as improved stability (reduced shrinkage coefficients).
Even though the mechanical properties of timber treated by this process increase, they do not match those of the most resistant tropical timber species. Although furfuryl alcohols are obtained from plants, the concept of "green chemistry" that is used in commercial language to reassure consumers involves strict procedures and controls; this "green chemistry" therefore carries risks.
This innovative technique is not yet sufficiently proven to predict its evolution over time, and it is possible that health risks may emerge over the medium or long term (direct contact with users' skin, progressive release of volatile compounds, etc.).

3.6.9. ASSESSING DURABILITY

In principle, laboratory testing consists of directly putting a material into contact with a biological degradation agent under optimal conditions of development and measuring the degradation of the material in terms of loss of mass. The tests are repeated with different agents, but they may not be exhaustive nor take into account synergistic effects that occur between agents or with the surrounding environment.
"Accelerated aging" consists in alternately placing the material in extreme environments (heat, humidity, dry environments, UV rays, etc.) according to several cycles. These two assessment methods can give an idea of the timber's actual behaviour when it is used, but biological agents are living organisms that require time to develop. The performance evaluated in a laboratory is therefore not always equal to that which is expected in the field.
The natural and untreated durability of tropical timber has been recognised for many centuries through various examples of use.

3.7. TIMBER MOISTURE

3.7.1. TIMBER MOISTURE RATE

Timber moisture is defined by standard EN 13183 as the ratio of the mass of water contained in timber over the mass of dry timber:
Note: the moisture of wood in standing trees varies between 60 - 200% depending on the species.

$$H\% = \frac{\text{Mass of water}}{\text{Mass of dry timber}}$$

Wood is an agglomeration of cells that are comparable to tubes, whose inner space is referred to as the cellular vacuum and whose walls are made up of several layers of cellulose. Different types of water have been identified in wood depending on its location:
Free water: it is contained in the cell vacuum. It is easy to extract from timber; its extraction is referred to as dewatering.
Bound water: it is inside cell walls and can only be extracted in the form of vapour; its extraction is known as drying. There is a third type of water called “constitutional water” which is crucial for the cohesion of the molecules that make up wood. Anhydrous* timber (H% = 0%) only contains constitutional water.
The behaviour of wood in relation to water is comparable to that of a sponge. When removed from water, it becomes soaked and swollen, and basic pressure is enough to extract the “free” water. This action, however, does not allow bound water to be extracted. To dry the sponge, it must be exposed to the driest possible environment in order to evacuate the “bound” water it contains by evaporation. When drying, the sponge becomes stiff and shrinks, like timber. No matter what the surrounding environment is like, an equilibrium is created over time between the water contained in the atmosphere and that which is contained in the material, see the hygroscopic* equilibrium abacus § 3.7.4. At the crossroads of the two phenomena is the fibre saturation point (FSP*), which is the moisture in timber when it is saturated with bound water without free water. This value is particularly important for withdrawal calculations because, below this level, moisture variations are accompanied by dimensional variations and the walls of the various cells will be deformed.

$$FSP = \frac{\text{Mass of saturated bound water}}{\text{Mass of dry timber}}$$

For temperate woods (resinous, oak, chestnut trees, etc.), the FSP has about 30% moisture. This value is arbitrarily applied in most documents. However, the FSP of tropical timber varies between 15% - 45% depending on the species. This characteristic is provided in the CIRAD* technical sheets and in TROPIX* software.
PLEASE NOTE: The data consists of averages and it is therefore possible to observe variations that are higher or lower than the displayed value.

Photo 15: Surface tension of timber © P. Martin, ATIBT

3.7.2. METHOD OF DETERMINING MOISTURE

The most reliable way to determine the amount of moisture in timber is by measuring the differences in mass. The humid mass, denoted by Mh, of a timber sample is determined by weighing. This sample is then dried in a furnace with ventilated air at about 100°C until its anhydrous* mass is obtained, which is denoted by M0. The mass of water contained in the sample is deduced by measuring the difference between that in moist timber and that in dry timber. Thus, the moisture rate is determined by:

$$H\% = \frac{(Mh - Mo)}{Mo}$$

Photo 16: Moisture metre using resistivity
© P. Martin, ATIBT

Some devices can be used to determine the moisture content of timber without destruction, provided that they are properly calibrated for that particular species of timber. There are two types of devices: those that measure resistivity and those that measure the capacitive effect. As timber is an insulating material by nature (thermal, acoustic, electrical, etc.), water is proportionally quantified in timber according to the behaviour of an electromagnetic field.

3.7.3. HYGROSCOPIC* EQUILIBRIUM

The moisture rate of stabilisation depends on the temperature and the relative humidity of the air in which it is located. This stabilised moisture of timber is said to be in hygroscopic* equilibrium with its surrounding environment. Equilibrium moisture rates can be estimated using the hygroscopic* equilibrium abacus (see § 3.7.4.). For example, for timber with a 30% FSP level that is located in an air-conditioned environment at a 20°C temperature and with a relative air humidity of 65%, the hygroscopic* moisture equilibrium approaches 12%.

PLEASE NOTE: The abacus is established for timber whose fibre saturation point is at 30% (equilibrium at 0°C and 100% air humidity). For tropical timber, whose FSP is much more variable, equilibrium moisture does not always match that of the abacus.
The time required for wood to reach its equilibrium moisture level varies depending on the timber species, its cross-section, its initial moisture level and perhaps even the air renewal. A controlled environment enables the drying time to be reduced (principle of artificial drying). In practice, the equilibrium moisture level is never reached because the moisture stabilises at a few percent above equilibrium moisture during the drying process and a few percent below equilibrium moisture during the humidification process.

H% MOISTURE RATE	DESIGNATION OF TIMBER WITH H% RATE	FORM OF WATER IN THE TIMBE
> FSP	Green or fresh timber	Free water, impregnation water and constitutional water
FSP	Saturated timber	Saturation point: maximum impregnation water (without free water) and constitutional water
22 to FSP %	Drained of semi-dry timber	Impregnation water and constitutional water
17 to 22 %	Commercially dry timber	
13 to 17 %	Air-dried timber	
< 13 %	Dried timber	
0 %	Anhydrous timber	Constitutional water

The trade names AD (air dried), KD (kiln dried) and SD (shipping dry) are frequently misused. Here are their definitions:
KD means "kiln dried". The achieved moisture rate must always be specified. It is generally between 9% - 22%.
AD means "air-dried". According to the preceding definitions, the moisture rate is between 13% - 17%. European standards have set this threshold at 20%. Please note: some producers and suppliers believe this term means "currently drying in the open", that is to say, often well above 20%. This misnomer can have serious repercussions; it is therefore necessary to be vigilant regarding the use of the term AD.
SD means "dry at embarkation". According to the INCOTERMS, sawn timber must be sufficiently dry to withstand transport without damage, especially by fungi. The moisture rate is not defined, but to meet these conditions, the timber must at least be dewatered (30% maximum moisture).

3.7.4. HYGROSCOPIC* EQUILIBRIUM ABACUS FOR TIMBER (30% FSP)

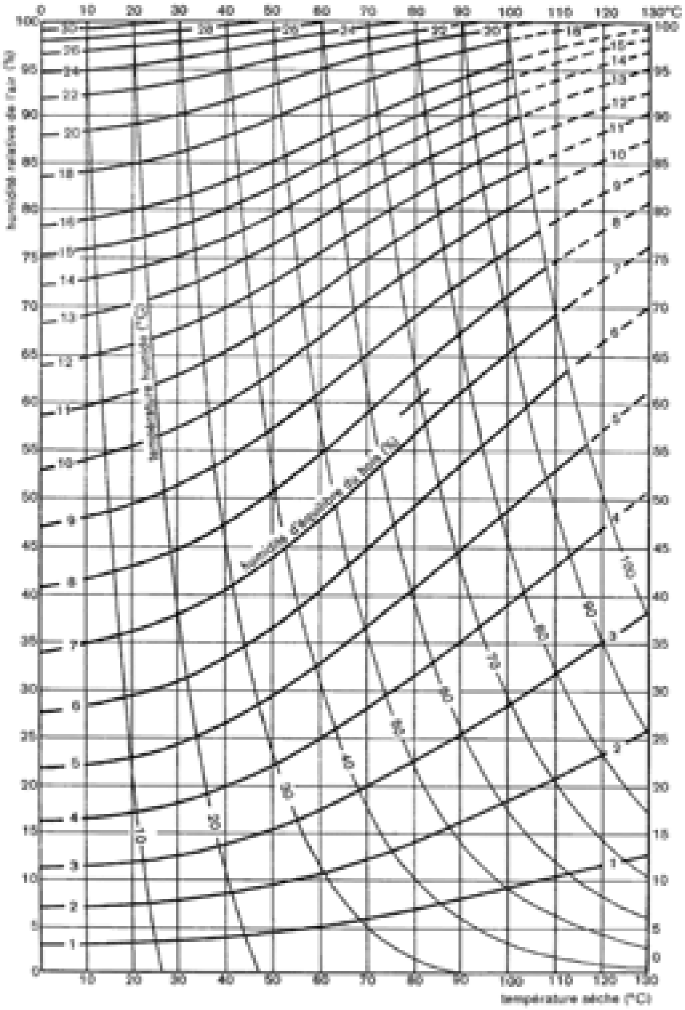


Figure 1: Keylwerth diagram

3.8. DIMENSIONAL VARIATIONS AND DEFORMATIONS

3.8.1. SHRINKAGE AND WARP

When the timber moisture rate is below the fibre saturation point (FSP), timber moisture variations are accompanied by dimensional variations, whose magnitudes depend on the direction that is examined (longitudinal*, radial* or tangential*).
Total shrinkage is the ratio of the variation between the timber's dimensions when it is in the green state (moisture greater than or equal to the FSP) and in the dry state (anhydrous* timber) divided by the dimensions of the timber in the state dry.

$$R = \frac{[\text{Dim (FSP) - Dim (0\%)}]}{\text{Dim (0\%)}}$$

where
Dim (FSP) = Dimension when H ≥ FSP
Dim (0%) = Dimension when H = 0%

Total longitudinal* shrinkage is the smallest, at about 0.1%; it is generally overlooked.
Total radial* shrinkage is greater, but remains limited due to the presence of ligneous rays; it stands at about 5%.
Lastly, total tangential* shrinkage is the most prominent, as no cell is oriented in this direction; it represents about 10%.
Total shrinkage is specific to each species.
Shrinkage is proportional to the moisture variation. The shrinkage coefficient α is equal to the dimensional variation for 1% moisture, in the moisture range between the FSP and the anhydrous* state.

$$\alpha = \frac{R}{FSP}$$

The dimensional variation is calculated using the following formula:

$$\Delta\ell = \frac{\alpha \times \Delta \times \ell}{100}$$

Where:
$\ell 1$ is the dimension at H1
$\ell 2$ is the dimension at H2
$\Delta\ell = \ell 1 - \ell 2$
$\Delta H = H1 - H2$

Photo 17: Timber shrinkage
© M. Vernay

PLEASE NOTE: The H1 and H2 values can never be greater than the FSP (if necessary, they are replaced by the FSP).
Note: The shrinkage values provided in the data sheets are averages; the variability of timber sometimes results in differences in relation to the theoretical calculation.

3.8.2. DEFORMATIONS IN TRANSVERSAL SECTIONS DURING DRYING

Due to the differences in shrinkage along the R and T directions, the timber deforms irregularly when it is drying. Since shrinkage in the R direction is less pronounced than in the T direction, it is said that timber "pulls towards the core" when it is drying. The phenomenon is inversed when moisture is recovered.

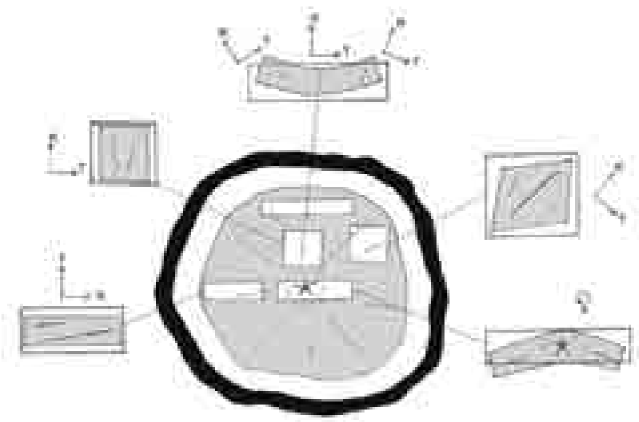
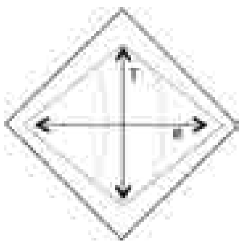
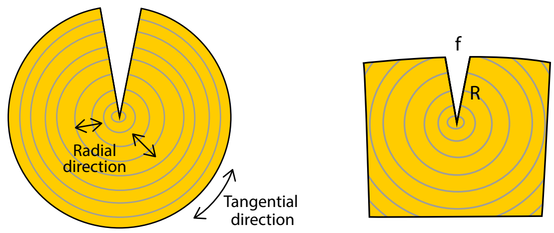


Photo 18: Deformation of sections during drying
© P. Martin, ATIBT

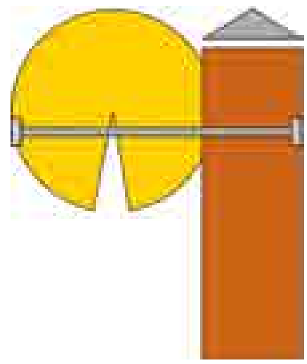
The justification of the deformation is easy to calculate:
Let's examine the following example: a square finger joint of Niangon measuring 12 cm diagonally, sliced from a half-quarter. If it passes from 28% to 12% of moisture, the deformations will be as follows:
Radial shrinkage:
ΔR = 0.131 x (28-12) x 120/100 = 2.5 mm
Tangential shrinkage:
ΔT = 0.275 x (28-12) x 120/100 = 5.3 mm
Where 0.131 and 0.275 are the respective coefficients of the Niangon's radial and tangential shrinkage.



The diagonal in the T direction will be smaller by 2.8 mm and will give a diamond shape to the piece.
In the case of a wooden log where the heart of the tree is enclosed, thus referred to as the "enclosed heart", the differences in radial and tangential shrinkage mean that the periphery of the section will tend to shrink more than the radius. As a result, either the timber supports the perpendicular tensile stresses in the tangential direction, or cracking will occur to release these stresses. Since timber's perpendicular tensile resistance is low, cracks will appear in most cases.



The positioning of cracks on round timber is difficult to predict. They occur over the shortest distances between the core and the edge, or in the most fragile areas (close to knots for example). These cracks generally have little effect on the mechanical strength of the timber, whose heart is enclosed (except in flexion when the crack is horizontal in terms of the pressure points). The timber's fibres are dissociated but not broken. However, they can trap water and thus facilitate fungal development, and expose portions of the timber that have received little or no treatment product.



On road guard rails, a preventive technique involves cutting the log halfway through the wood. This cut, called the "discharge notch", releases the deformation stresses and therefore limits the occurrence of cracking in undesired areas (for example, at the joints).
The opening of the cut varies depending on the variations in moisture. It is performed before treatment and it is oriented towards the lower section so that it doesn't create a water trap.
Certain structural elements that are large are reconstituted with glue. They are much more homogeneous and stable. Deformations and the risks of cracks are greatly reduced. Among other products, they include: glued laminated timber, engineered timber, plywood, etc.

3.9. DRYING

Timber can be dried using different processes: natural drying and artificial drying.

3.9.1. NATURAL DRYING

The circulation of air - and potentially the heat produced by solar energy - favours the evaporation of the moisture contained in timber. In order to facilitate the circulation of air between sawn timber, it must be spaced apart using spacing boards known as rods. In practice, sawn lumber is stacked over several rows (or beds) and spaced apart by the height of the rods that are placed perpendicularly along its length. This packing technique is the most common; it incorporates concepts relating to ventilation, as well as ease of handling and transport.
The width of the packages must remain below 1.80 m, otherwise the air circulation speed will be insufficient. The packages are stacked at a height that is limited by their stability. If the sawn timber that is to be packed features different lengths, the longest pieces must be placed on the first row and follow in decreasing order of size.
The thickness of the rods depends on the thickness of the timber that is to be dried. Here is an example of the recommended rod thickness for optimal natural drying:

TIMBER THICKNESS (IN MM)	ROD THICKNESS (IN MM)	SPACING OF THE RODS (IN CM)
18 to 20	20	30 to 40
20 to 40	25	40 to 50
40 to 50	30	50 to 60
50 to 65	35	70 to 80
65 to 85	40	90
> 85	45	100

In order for a package to accommodate a new row of sawn timber, the rods must be positioned exactly above those supporting the previous row. The ends of the timber must be supported while ensuring that the rods do not exceed their length, in order to avoid bending deformations during the drying and to limit the occurrence of cracks at the ends of the timber.
Other methods are available to reduce the risk of cracking at the ends, by applying an anti-crack product (made with microcrystalline emulsion wax), by nailing battens or strips, or even by pushing metal or plastic “S” pieces into the ends of the sawn timber.
The sawn timber must be placed in each row with a minimum spacing of 1 cm between the edges.
The maximum recommended rod spacing:

BOARD THICKNESS	OVER 50 MM	FROM 50 MM TO 25 MM	UNDER 25 MM
Soft timber	1,000 mm	600 mm	300 mm
Hard timber or timber that tends to deform	600 mm	400 mm	300 mm

The rods must be dried and possibly treated if they are not naturally durable. They are always made using a species that is not likely to produce stains on drying timber.
One of the most important parameters of the drying that needs to be under control is the exposure of the packages to bad weather. Frequent exposure to rain prevents the timber from drying and can favour the development of fungi. Conversely, exposure of the timber to the intense heat of the sun can cause deformations or cracks. Storage under an open shelter or under a basic metal sheet outdoors is recommended to favour drying.
Timber packages must be erected on stable and possibly drained foundations. The lower package must be raised in order to favour ventilation and reduce the effects of ground moisture. The extra height must be at least 40 cm.

Photo 19: Natural drying on concrete blocks © M. Vernay

3.9.2. TRADITIONAL ARTIFICIAL DRYING

The most frequently used artificial drying technique consists in placing the timber packages in an enclosure where the moisture, ventilation and temperature are controlled in order to optimise the drying speed. The dryers are differentiated by the type of forced ventilation they use (longitudinal, upper or lateral) and by their heating technique (steam, hot water, hot oil, hot air or electricity).

PLEASE NOTE: The term "autoclave" is inappropriate to designate equipment intended for drying timber, because an autoclave aims, on the contrary, to increase the moisture content of timber.

The pile is formed using rods that are 22 mm thick.

Maximum spacing of the rods:

THICKNESS OF THE SAWN TIMBER	OVER 50 MM	FROM 50 MM TO 25 MM	UNDER 25 MM
Hard and soft timber	600 mm	300 mm	200 mm
Timber that tends to deform	300 mm	200 mm	200 mm

The optimal air speed for the drying of most timber species is 3 metres per second. The dryer operation requires the installation of probes on a few pieces of sawn timber inside the packages in order to measure moisture and temperature. According to these measurements, the dryer operating instructions are modified in order to optimise the extraction of the water until the desired moisture level is reached. The water extracted from the timber (in the form of vapour) is eliminated by ventilation and then condensed by a dehumidification system.

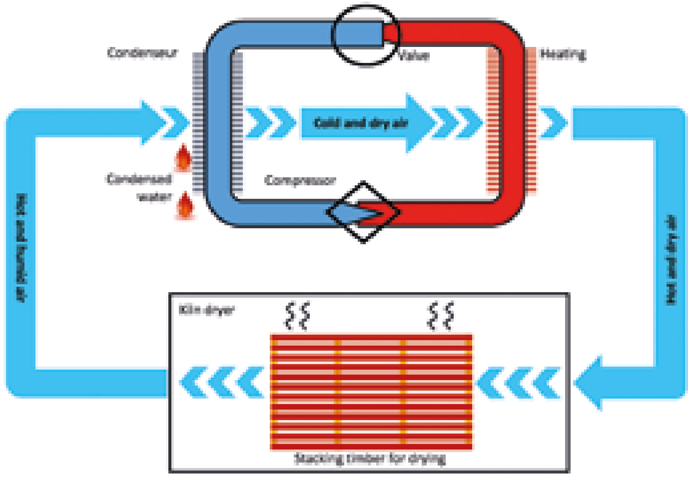


Photo 20: Principle of kiln dryer © P. Martin, ATIBT

Specific case of vacuum drying

As the pressure decreases, the water evaporation temperature also decreases. This principle is used in vacuum dryers by means of a steel tank in which subatmospheric* pressure is generated. The heat generated inside the tank is provided by the circulation of hot water inside of aluminium plates placed between each row of square-edged timber. The water contained in the timber evaporates and condenses when it comes into contact with the tank's wall, and is then evacuated outside of the tank.

This type of dryer enables small quantities of timber to be dried very quickly. However, it nevertheless has a few disadvantages: more handling, more energy consumed and drying that is more heterogeneous.

3.10. GLUING

Gluing involves putting two surfaces into contact with each other and joining them in a perennial manner. The assembled element must be able to withstand the chemical, physical and mechanical stresses which it will normally be subject to during its lifetime. Gluing ensures continuity and an excellent distribution of effort, even if the materials joined together have different properties. According to this principle, the production of glued products not only makes it possible to obtain large elements (in terms of section or length), but it also homogenises properties, improves mechanical performances and stabilises the behaviour of the material in relation to moisture. This industrial process favours the enhancement of the value of small elements and increases material yields.
The diversity of available glues offers a wide range of solutions that enable virtually all types of bonding. It is therefore advisable to select glue that is consistent with the machining that is planned and the parameters of implementation.

The choice of glue is made according to several criteria:

- the properties of the timber that is to be bonded: density, surface condition, moisture, shrinkage, treatment, etc.;
- the equipment used: workshop, equipment, storage, pasting, tightening, cleaning, etc.;
- the timber's positioning: along the wood grain or against the wood grain and type of cutting;
- the products' intended use: structural or non-structural usage;
- the implementation situation: dry or wet interior, sheltered or exposed exterior.

There are several types of glues:

- vinyl glues, referred to as white glues: they are designed for the bonding of hydrophilic* materials. They are made of polyvinyl acetate (or PVAc) in an aqueous solution.
- aminoplast glues are thermosetting* polymers, which include urea-formaldehyde (UF) and melamine-formaldehyde (MF) glues
- phenoplastic glues, such as phenol-formaldehyde (PF) glues
- polyurethane glues (PUR), which are water-resistant glues
- Emulsion Polymer Isocyanate (EPI) glues, which are adhesives with two components: a polymer containing reactive hydroxyl groups and a hardener that is a protected special isocyanate. These adhesives are highly resistant to water

The adhesives are listed in 4 classes according to their ability to withstand various exposures and ambient environments (subject to controlled conditions of implementation). Two subclasses distinguish thermoplastic* glues (C) from thermosetting* glues (D).

CLASS	DESTINATION AND SURROUNDING ENVIRONMENT
D1 or C1	Interior where the temperature occasionally (and for short periods of time) exceeds 50°C and where the timber's relative moisture does not exceed 15%.
D2 or C2	Interior in contact with runoff water or occasional condensation for short periods of time and/or subject to high air moisture levels for limited periods, where the relative moisture of the timber can reach 18%.
D3 or C3	Interior in contact with runoff water or frequent condensation for short periods of time and/or subject to high air moisture levels for extended periods. Exterior protected from bad weather.
D4 or C4	Interior in contact with runoff water or significant and frequent condensation. Exterior exposed to bad weather provided that a suitable surface coating is applied to the bonded structure.

Some tropical species may be difficult to bond together due to their density, the presence of certain extracts or concretions in the timber's vessels, such as Doussie, Framire and Wengé. Professional consensus is unanimous, it is strongly advised that glue-lines be refreshed and, if necessary, they should be degreased. To do this, the most popular method consists in successively cleaning the surfaces to be glued with a cloth soaked in white spirit, alcohol and acetone. Double gluing and scratching the surfaces also favours the transfer* of the glue and greatly improve the hold of the glue-lines.

4. TIMBER PRODUCTS FROM CENTRAL AFRICA

4.1. THE FORESTS OF THE CONGO BASIN

The Central African forests located in the Congo Basin region are home to the second largest tropical rainforest in the world, covering an area of nearly two million km² (Mayaux et al., 1998). The forests of the Congo Basin are distributed across six countries: Cameroon, Gabon, Equatorial Guinea, the Central African Republic, the Republic of Congo and the Democratic Republic of Congo.

The dense forests of the Congo Basin cover an estimated area of over 160 million hectares and they represent 10% of the world's biodiversity. The forests of Central Africa belong to the States. For part of the forest area, forestry management is entrusted to concessionaires, mainly through long-term forestry concessions. Today, over 40 million hectares of forestry concessions are assigned over the long term and represent the bulk of the Congo Basin's production forests[2].

However, the forestry sector remains one of Central Africa's main catalysts for economic development. We must not lose sight of the growing presence of Asian (mainly Chinese) economic players in Central Africa, which is changing the regional timber sector landscape and creating new opportunities. Nevertheless, the lack of visibility in terms of Africa-Asia and Asia-Europe import/export flows is hindering the development of relationships with markets in Asia, where certification has already extended its networks: in Malaysia, Indonesia and China for the PEFC, and in Vietnam, China and - to a lesser extent - in Thailand for the FSC. Compliance with EUTR* requirements would allow the pursuit of trade relations with Europe.

Photo 21: Satellite image of the Congo Basin © ONFI

These forests are subject to growing pressures, whether in terms of demand for mineral and energy resources, population growth, urbanisation or the infrastructures required to access these resources. These pressures are likely to accelerate the degradation of forests, which are also coveted by agro-industrial players in the palm oil sector. As production capacity is reaching saturation in major producer countries such as Indonesia and Malaysia, multinationals are now turning to Africa to meet the ever-increasing global demand for palm oil.
N.B. These forests are subject to deforestation that is much lower (0.26%) than those in Central America (1.23%) and South America (0.41%), and those of Southern and South-East Asia (0.33%)[3].
These problems are compounded by the limited resources that forest administrations have to ensure effective control of their activities.
Legal and certified African timber's easier access to regional and global markets is a means of contributing to the economic viability of responsible logging and the development of industrial facilities. This dynamic would encourage forest operators to either maintain the certification process (of legality or forestry management) or to commit themselves to it. If the various institutional, social, political and economic contexts that benefit from the certification tool are able to influence forest usage decisions, then trade will remain an undeniable driving force for the sustainable development of tropical forests.

4.2. PRODUCTION

Although Africa's timber production accounts for 18% of global volumes, lumber only accounts for 4% of the world's production.
PLEASE NOTE: The production data presented in this document only covers the formal activity sector (mainly the industrial segment).
It is noteworthy that in the Congo Basin, the forest/timber sector is a driving force of the national economy in many countries. Also, the artisanal and/or informal sector's market share is very large and may even exceed that of the formal sector (see studies conducted by the CIFOR on this subject). The domestic market draws primarily from this sector for its timber supplies.
Among the species produced, Okoumé[4] is the leading species exploited in Central Africa (primarily in Gabon and Congo). It is followed by the Sapelli, which is produced throughout Central Africa, especially in Congo and Cameroon. Lastly, the Ayous[5] is the third most exploited species, coming mainly from Cameroon. Other species are produced at lower levels[6], due to their limited

	SURFACES MILLION HA	INVENTORY BILLION M³	TOTAL PRODUCTION-MILLION M³	ENERGY TIMBER-MILLION M³	LUMBER MILLION M³
North America	613	68	679	48	631
South and central America	924	139	451	280	171
Europe	203	29	479	107	372
Russia	809	80	191	46	145
Afrique	**635**	**65**	**654**	**588**	**66**
Asia and Oceania	767	53	1083	802	281
TOTAL	3,951	434	3,537	1,871	1,666

(Source: E. Groutel, WALE 2016)

2 - Verhegghen & Defourny, 2010, in De Wasseige C., by Marcken P., Bayol N. (2010) Les forêts du bassin du Congo - Etat des Forêts 2010 (Forests in the Congo Basin - State of the Forests in 2010).
3 - K. Picquenot et al. (2012) Market study of certified tropical timber opportunities in the European market (project to support the eco-certification of forest concessions in Central Africa, ECOFORAF, AFD, ATIBT, GEF), ECOFORAF, AFD, ATIBT, FFEM).

Photo 22: Rotary cutting © B. Demarquez, TEREA

Photo 23: Sawn timber © P. Martin, ATIBT

potential (localised area of distribution, high production costs, species that are scarcely known on the markets, etc.).

Central Africa's ten leading companies - whose industries are primarily backed by foreign capital - account for between 40% - 50% of production. The OFAC (Observatory for the Forests of Central Africa) notes that: "the industrial sector's production is mostly exported, the local market is currently mainly supplied by the artisanal sector. Industrial players only have a marginal share of the domestic markets, with a few notable exceptions, such as the plywood sector in the DRC, which is entirely oriented towards the local market. The regional market, both in Central Africa and across the rest of the continent, is also significantly underdeveloped".

In terms of products, exports from Central Africa mainly include logs and products resulting from primary processing (sawn timber). Secondary processing (mainly plywood production) is very limited. The main export destinations for this Central African timber are Asia and the European Union. Accounting for nearly 60% of the volumes exported from 2005-2008, the Asian market tended to enhance its position in 2009, during the heart of the crisis, by claiming 70% of export volumes (source: OFAC). Europe consumes a great deal of plywood from the Congo Basin. However, most of this plywood is not processed in Africa, but in Asia, before being re-exported to Europe.

Like many other sectors, the Congo Basin's timber industry was confronted with the 2008-2009 global recession. This resulted in a sharp decline in demand, which was accompanied by lower prices (more pronounced on trunks than on sawn timber). According to the OFAC: "the crisis probably caused about a third of the world's tropical timber trade to evaporate. The EU countries recorded a drop in tropical timber imports exceeding 40% over one year (2008-2009)". Some companies in Africa suffered considerable financial losses and certified companies were not spared.

4.3. LEVELS OF PROCESSING

The processing level concept is commonly used in the timber industry in virtually every country in the world. But the number of levels and their definition varies greatly from region to region. These definitions have consequences in terms of traceability, declarations, statistics and taxation. They are sometimes formalised in writing, and even

4 - 1.4 million m^3 of logs produced in 2008
5 - Approximately 900,000 m^3/year
6 - Not exceeding 200,000 m^3/year

included in national regulatory texts.
In a majority of cases, the timber industry considers that there are three processing levels, which are independent of the number of processing steps required by a product. A standardised definition seems essential in order to clarify the subject and prevent any distortions caused by competition.

Here is a definition of the levels of processing that can be agreed upon:

- **primary processing:** all of the processes directly applied to round timber that make it possible to obtain another product. Examples of products produced by primary processing are: squared* timber, rough-edged boards, blocks, sliced and unrolled veneers, split timber, platelets, sawdust, wood chips, paper pulp, firewood, charcoal, etc.
- **secondary processing:** all of the processes applied to products having undergone primary processing and which make it possible to obtain semi-finished and/or profiled elements. Products resulting from secondary processing are products that have undergone drying, treatment, planing, moulding and gluing processes, etc. Examples of products produced by secondary processing are: treated timber, artificially dried timber, planed timber, moulded timber, sanded timber, solid timber boards (flooring, cladding, panelling, decking), pellets, briquettes, etc.
- **tertiary processing:** all of the processes applied to products having undergone primary or secondary processing and which make it possible to obtain finished products (no further processing is necessary). Examples of products produced by tertiary processing are: furniture, joinery, industrial trusses, laminated flooring, casks, railway sleepers, pallets, paper, cardboard, etc.

Example of a processing chain that enables the production of windows:

PRIMARY PROCESSING:
Sawmill producing sawn timber
SECONDARY PROCESSING:
Factory producing laminated finger joints
AND TERTIARY PROCESSING:
Workshop manufacturing windows from finger joints

A factory can combine several levels of processing, such as rotary cutting, drying and plywood manufacturing, not to mention the sawing and profiling of patio floorboards.
PLEASE NOTE: When some countries only take into consideration two levels of processing, primary processing encompasses everything that can be done in a sawmill, including treatment, drying and even planing, and secondary processing includes all of the processes required to produce finished or semi-finished products. The notion that a processing level is a step in the overall manufacturing process of a product cannot lead to a hierarchical system. Indeed, the steps can be quite numerous for the manufacture of certain products, but some steps may not be needed to produce similar products. In this sense, a 4th (and sometimes even a 5th) processing level can lead to confusion and an incoherent hierarchy. This system is therefore not recommended.

4.4. SAWING

4.4.1. CLASSIFICATION ACCORDING TO APPEARANCE

When timber is used for the manufacture of joinery, furniture, floors or other products in which aesthetic considerations are at stake, users are looking for batches of sawn timber that display the least amount of defects. To meet this need, rules that rank the appearance of timber have been defined to distinguish between the various qualities; they are also referred to as “choices”. There are two ways of ranking the appearance of sawn timber:

1. The “Imperial Classification”, according to the number of “standard” defects that an assessed piece presents according to its dimensions. Defects in appearance may include knots, cracks, resin pockets, stitches, sapwood*, etc. Some of them may be tolerated depending on their number and size, but others are not tolerated regardless of the desired choice. This is the system that is most often used in Africa right now.
2. Classification according to clean cuts, in which the worst side of the piece to be classified is examined. Here, the proportion of fictitious pieces free from defects which may be cut out is evaluated. This net percentage of defects helps determine the choice of a piece. This is notably the principle that is used in the SATA (Sciages Avivés Tropicaux Africains - African Tropical Sawn Timber) classification rules.

For many years, the “Imperial Classification” was actually an oral ranking system, until some producers and importers translated it into written form. The names of the choices are in English: First and Second, no. 1 Common and Select, no. 2 Common, Prime, etc. Although these rules appeared before those based on the principle of clean cutting, they use the same names, which can lead to confusion.

4.4.2. STRUCTURAL CLASSIFICATION

When timber is to be used for structures (posts, beams, joists, backing strips, etc.), justification must be provided to ensure that the structure is safe. Such justification can only be provided with calculation code prescriptions, such as those found in the Eurocodes*. In order to calculate the dimensions of a work’s structural timber, it is necessary to know all of its mechanical properties. It is for this purpose that standard EN 338 defines mechanical classes (C14 to C45 and D18 to D80). To qualify for a mechanical class, two options are available for each species: classification by machine using a specific setting, or visual classification, tolerating certain defects.

PLEASE NOTE: Mechanical classification is essential for the CE marking of structural timber.

For a single species, it is possible to obtain different mechanical classes depending on the significance of the defects and the rules that are used. The European classification’s various rules are referenced in standard EN 1912. European standard EN 16737, which is specific to the visual classification of tropical timber, has just emerged in order to standardise this work.

Given the multitude of tropical species that can be used for structures, a laboratory qualification for each of them represents a disproportionate cost. To meet the requirements of CE marking, the secure mechanical classification of 72 tropical species has been defined in standard NF B 52-001 through the extrapolation of CIRAD* data (see Annex 2).

4.4.3. COMMON SECTIONS

The contractual dimensions of sawn timber are based on a 20% moisture level. Extra length must be provided for in the sawn timber in order to account for shrinkage due to drying with up to 20% of moisture. Normalised sections depend on the classification rule that the quality refers to. The most common thicknesses are: 15, 18, 22, 27, 34, 41, 45, 55, 65, 80, 100, 125, 150, 175, 200 and 225 mm. Below 1.80 m in length, the timber pieces are “Shorts” (spurs). The lengths are by multiples of 25 cm. Below 15 cm in width, the timber pieces are “Narrows”. The widths are by multiples of 25 mm.

4.5. VENEERING

Veneers are the name given to timber sheets that are under 6 mm thick, obtained by rotary cutting (total or semi-circular), slicing or sawing. Veneering is mainly intended for the manufacture of plywood panels. It is also used as a coating for solid timber and blockboard or chipboard panels, as well as to produce laminated beams, floorboards and packaging.

Plywood is made using different types of veneers:

- Inside face and outside face: veneers specially designed for the inside and outside faces of panels

- Inside (cross thread): layers for the interior of the plywood panel whose thread is perpendicular to the outer layers
- Core (long thread): layers for the inner part of the plywood panel whose thread is parallel to the outer layers

Each factory adapts to the dimensions of its machines, but the following are the most common dimensions:

LENGTH IN CM	WIDTH IN CM
257	127
257	158
257	175
317	158
317	188

The reference moisture level is set at 10 ± 2% for the determination of dimensions and their associated tolerances, unless otherwise specified in the contract.

The classification of the aspects qualifying rotary cut veneers is based on the presence, number and significance of singularities*. It refers to ATIBT's technical guide for the marketing of tropical veneers and to the ISO 2426-1 and -2 standards (identical to standards EN 635-1 and -2) relating to the definition of singularities* and to the classification of aspects of plywood panels made from hardwood species. There are a total of five choices, in decreasing order of quality: E, I, II, III and IV.

4.6. CE MARKING

The European Union has decided to harmonise national regulations overseeing construction products with the introduction of the Construction Products Regulation, which describes the principles of (European Community) marking. The aim of this marking is to make manufacturers and suppliers more accountable by requiring them to disclose the performances of construction products that are subject to a harmonised standard*, thereby limiting the barriers to trade of products that are marketed in the European Union.

CE marking is a guarantee to users that the construction products comply with the requirements established for their intended use, that is to say, they have the necessary characteristics that will enable the construction works to meet seven essential requirements:
- Mechanical strength and stability
- Safety in the event of fire
- Hygiene, health and the environment
- Safety of use
- Protection against noise
- Energy savings and thermal insulation
- Sustainable development

Product standards describe the performances that are to be evaluated, their measurements, how they are assessed and the display mediums that will be used to market them. The regulation stipulates that CE marking can only be applied if the producer has a factory production control system, similar to an "ongoing internal control of production, performed by the manufacturer". Lastly, the producer has an obligation to respect the certification system imposed on the product (in accordance with its use) and to mark CE on its products (while also listing certain technical characteristics). Product marking must be visible, legible and indelible.

As part of the implementation of the CE marking system, several players are involved and they have different responsibilities:

Manufacturers (or agents or importers), responsible for the declaration of performance (DoP) and for the affixing of the CE marking;

Approved bodies, which participate in the attribution of CE marking rights by issuing conformity certification to the manufacturer after tests and/or inspections have been carried out;

National supervisory authorities or Member State enforcement authorities, which are in charge of overseeing the proper implementation of the directive.

The absence of CE marking is a criminal offense resulting in a fine and/or confiscation of the products. Other specific procedures exist for non-traditional or innovative products (not described by a harmonised European standard).

5. FOCUS ON FORESTRY CERTIFICATION AND TIMBER LEGALITY IN AFRICA

5.1. TIMBER CERTIFICATIONS SUPPORT THE RESPONSIBLE MANAGEMENT OF AFRICAN FORESTS

5.1.1. THE VARIOUS RESPONSIBLE FOREST MANAGEMENT CERTIFICATIONS

Presented as a means of ensuring that tropical timber has been harvested with respect for the environment and local populations, the development of forestry management certification has enabled concerted thought to be given to a shared definition of sustainable forest management and how to assess it in the field. Supported by numerous environmental NGOs since the Rio conference in 1992[7], certification is a differentiation tool for the timber markets. In short, this tool makes it possible to quickly inform the end user, via the affixing of a label on the certified timber product, in order to reassure him regarding his choice of purchase. Certification is based on a list of requirements organised according to standards, which must be respected by the companies that are applying to obtain the certificate. An audit is carried out by an independent third party, and if the implemented actions are compliant, an annual certificate can be issued. There are two distinct types of certification that are applied in the Congo Basin:

- forestry management certification, of which the main brands are the Forest Stewardship Council (FSC) and the Program for the Endorsement of Forest Certification schemes (PEFC);
- legality certification (OLB and TLV[8] labels), which adheres to the traceability principles and focuses on compliance with the production country's currently applicable laws. This type of certification is often the first step of a progressive certification approach leading to responsible forestry management.

In the three main tropical forest basins (Asia, Amazonia and Africa), the most prevalent forestry management certification is FSC (nearly 70% of all certified areas). The PEFC system is used in 22% of the certified areas[9].

In the Congo Basin forests, certification is fairly recent: the first OLB certificate was issued in 2004 and the first FSC certificate was issued in 2005. Currently, all labels combined, approximately 20% of the surface areas of the forestry concessions attributed in the Congo Basin are certified. Over 10% of the surface areas are covered by the FSC label, representing about 5.5 million hectares managed by a dozen companies.

Much progress has yet to be made, though, as few companies - with the exception of large groups - are certified. However, cases in which exploited forests are not managed are becoming increasingly rare. **It is essential that certifications gain ground; this is the objective of the dynamic steered by ATIBT and its members, through its marketing programme which promotes certified African timber produced by sustainably managed forests.**

7 - Earth Summit of Rio de Janeiro from 3 - 14 June 1992 under the aegis of the United Nations

8 - Origin and Legality of Timber (OLB) is developed by Bureau Veritas, while Timber Legality Verification (TLV) is a system developed by the Rainforest Alliance

9 - K. Picquenot et al. (2012) Market study of certified tropical timber opportunities on the European market (project for the backing of forest concessions in Central Africa, ECOFORAF, AFD, ATIBT, FFEM).

5.1.2. PRINCIPLES AND BENEFITS OF RESPONSIBLE FOREST CERTIFICATION IN CENTRAL AFRICA

Forest management certification is based on a set of specifications, referred to as a frame of reference, consisting of 10 general principles and criteria to be met. This frame of reference is regularly revised - in a concerted effort with the various stakeholders - in order to adapt the application of the criteria to the field and to ensure the continuous improvement of the overall standard.

The FSC label is affixed to products from FSC certified forests, in order to highlight the efforts made by forestry companies. It informs the public that the certified product meets transparent specifications that have been verified by accredited independent certifiers.

Photo 24: Marking and traceability of logs © CIB

FSC requirements address forestry management aspects that are economic, environmental and social, and they do so at the forest management unit* level. The high standard expected in the field compels companies to continuously develop more skills, in collaboration with technical partners and the research sector. The partnership between PALLISCO and the Zoological Society of London in Cameroon for the concerted development of a wildlife management programme and the partnership between Nature+ and WIJMA Cameroon for forest enrichment improvement, are two examples.

The certified forest management practices of tropical natural forests involve numerous investments in a variety of areas:

- **Socio-economic development at the local level:** certified forest companies are significant sources of both local direct and indirect employment in Central Africa. In addition, certified companies build and provide schools, clinics and housing in close proximity to the workplace in order to enable employees and their families to be housed in decent conditions and have access to health care, clean water and education.
- **Support for good forest governance and enforcement of the law** in the countries covered by the certificate. In the countries covered by the certificate. The first FSC principle, entitled “Compliance with the Laws and Principles of the FSC”, recognises all of the legal texts, as well as the international conventions that have been signed by the countries where certified management is implemented. Independent audits and the availability of public reports ensure the transparency of the system.

Photo 25: School built by an FSC company © B. Demarquez, TEREA

- **Preservation and conservation of forest ecosystems, as well as biodiversity** in general. This is principle no. 9, dedicated to the management of High Conservation Values (HCV)[10]. For several years, companies have implemented systems to manage and monitor these HCVs with the regional and international experts. These schemes contribute to the furthering of knowledge on forest dynamics[11]. An increasing number of companies are also adhering to principles of Reduced Impact Logging (RIL): protection of sensitive areas (riversides, steep slopes), controlled felling, planning of works and road construction and, if necessary, the enrichment of felling gaps and the reforestation of degraded lands.

- **Involvement of local communities in forest management** through the establishment of partnerships based on trust that allow for better collaboration in the implementation of the management plan and that will span a sufficient duration (at least 30 years). For example, in many certified forest concessions, hunting and anti-poaching enforcement is carried out in partnership with the village's hunting committee and eco-guards.

Such large-scale responsible management contributes to the long-term preservation of ecosystems and makes it possible to bring together various players involved in the spatial planning and resource planning processes. These elements are at the heart of the so-called "landscape" approach, which contributes - at the local level - to bringing together various activity sectors (industrial ecology and clusters) and - at the national level - to the country's economy (conservation, forest management, agriculture).

But, above all, certification remains a commercial tool. The added value of a certified product must guarantee the economic viability of the activity, while taking into account the efforts undertaken by companies in the field. This economic value placed on forest resources and responsible management practices preserves forest land from illegal logging and from the conversion to industrial agricultural plantations. Buying certified tropical timber is therefore a way to support responsible practices and to participate in the continuity of socio-environmental benefits in the field.

Photo 26: Forest path in a certified concession
© M. Leblanc

10 - Concept that defines several types of values of forests that are to be preserved. Examples: HCV3, forest areas containing rare, threatened or endangered ecosystems; HCV5, forest areas that are fundamentally necessary to meet the basic needs of local communities.

11 - Natural tropical forests are of such diversity that their long-term dynamics remain relatively unknown. The effects of the first implemented management plans on countries' ecosystems must be evaluated over a sufficiently long period to be significant.

5.2. THE LEGALITY AND TRACEABILITY OF TIMBER IN AFRICA

As they are produced by certified forests, certified products go through a multitude of steps before they reach the final consumer (forest harvesting, log trading, processing in sawmills, exportation, trading, processing into finished products, distribution). The chain of control, also referred to as the "Chain-of-Custody" (CoC), is a fundamental point in terms of certified timber products' traceability. Certification of this chain of custody is a guarantee to the final consumer, that traceability requirements are respected and that the marketed timber product comes from a certified forest. In a more global context, traceability has also become an essential condition in markets with high standards such as those in Europe, now regulated by the European Union Timber Regulation (EUTR*). The EUTR* came into effect on 3 March 2013. It aims to combat illegal timber trade through the implementation of a new verification and accountability strategy in the private sector, by targeting European demand for timber products and by-products, except for recycled products, published products, rattan and bamboo. It defines requirements for the private entities that introduce timber and timber by-products into the European market: this is due diligence. Each producer must implement risk analysis of its suppliers and be able to demonstrate that the timber products it sells are of legal origin and that this origin can be traced from its supply chain.

A producer whose chain of custody is certified according to a voluntary label recognised by the forestry administration of the producing country can obtain a FLEGT* certificate and provide it to the importer in order to justify the legality of the timber that is marketed.

This regulation, adopted in 2010, is part of the FLEGT (Forest Law Enforcement Governance & Trade) action plan that was launched in 2003 by the European Commission.

As far as African producer countries are concerned, guaranteeing traceability is a major challenge for companies, within the context of the implementation of the Voluntary Partnership Agreements (VPA*).

Although certification is part of a voluntary effort by companies in response to market requirements for guarantees regarding timber legality and responsible forest management, there are considerable synergies between the FLEGT* VPA* and the EUTR*.

PART 2

THE PROPER USE OF ECO-CERTIFIED AFRICAN TIMBER

The structural sheets in this chapter are based on a common structure:
- Definition and role
- Stresses
- Required properties
- Principles of implementation
- Usage class
- Species

The structures are grouped into 7 categories, according to various usage types. Each type of usage has a level of requirements that makes it possible to select the species that are best suited for each usage situation:

1 Structures and panels
- 1.1 Lightweight structures
- 1.2 Glued laminated timber
- 1.3 Finger joints
- 1.4 Plywood, inside face and outside face
- 1.5 Plywood, inner layers
- 1.6 Sliced veneer

2 Exterior joinery (building facade)
- 2.1 Cladding and outer coating
- 2.2 Windows and doors
- 2.3 Screen walls and solar shading
- 2.4 Shutters and closures

3 Carpentry and interior fittings
- 3.1 Wooden floors
- 3.2 Interior staircases
- 3.3 Doors and door frames
- 3.4 Moulding
- 3.5 Interior panelling and cladding
- 3.6 Layout and furnishings
- 3.7 Furniture and cabinetmaking

4 Outdoor equipment - Recreation
- 4.1 Exterior staircases and guard railing
- 4.2 Single-level terraces and pool areas
- 4.3 Elevated terraces, balconies and corridors
- 4.4 Shelters, outdoor furniture and playgrounds
- 4.5 Gates
- 4.6 Visual barriers and windbreak panels, pergolas

5 Industrial usage and heavy work
- 5.1 Hydraulic works in a submerged marine environment
- 5.2 Structures and bridges in contact with soil or freshwater
- 5.3 Acoustic screens in urban areas along railroads and highways
- 5.4 Crossing and dunnage
- 5.5 Industrial floors and heavy framework
- 5.6 Vehicle, wagon and container bottom (or floor)

6 Shipbuilding
- 6.1 Boat decks and planking
- 6.2 Boat and yacht layouts
- 6.3 Pleasure-boating pontoons

7 Miscellaneous uses
- 7.1 Cooperage and vat making
- 7.2 Turnery, cutlery and brushmaking
- 7.3 Tool handles
- 7.4 Musical instruments
- 7.5 Sculptures
- 7.6 Packing and crating

Note:
At the request of African certified timber producers, the Afzelia Pachyloba species (known as Pachy) is distinguished from the other species grouped in the ATIBT designation under the name Doussié.

1. STRUCTURES AND PANELS

1.1. LIGHTWEIGHT STRUCTURES

DEFINITION AND ROLE

We use the term "framework" to refer to all of the elements that constitute a roof-supporting structure and the term "frame" to refer to the set of horizontal and vertical load-bearing parts of a construction.
The framework supports the roofing, using the various elements it consists of: tie beams, rafters, puncheons, hinges, purlins, etc. We differentiate traditional solid timber assembled frameworks from industrial frameworks consisting of thin calibrated boards assembled using metal connectors.
The frame generally consists of: beams, posts, joists, ledger boards, bracing, etc.

STRESSES

Stresses are essentially mechanical. The structure directly supports vertical loads (own weight, roofing, etc.), as well as overloads inherent to its function and its position within the construction (usage, climatic overloads, etc.). Although generally sheltered, light structures are subject to slight or occasional moisture (condensation, sprays, etc.).

REQUIRED PROPERTIES

Mechanical resistance is classified according to the "CE marking" requirements described in standard EN 14081. In addition to the mechanical classification established when the parts are to be selected, the timber must demonstrate good cuttability and have a good resistance/density ratio.
Depending on the usage situation and the risk of exposure to biological degradation agents, an insecticidal fungicide treatment is required if the natural durability of the selected species is insufficient.

PRINCIPLES OF IMPLEMENTATION

Lightweight structures are assembled mechanically on site. For species with insufficient durability, cuts and trims on construction sites must be retreated. Industrial frameworks (small farmhouses) are assembled at the factory and simply installed and positioned on site. Implementation recommendations are specifically described in standards NF-DTU 31.1 for traditional frameworks, 31.2 for frames and 31.3 for industrial frameworks.

USAGE CLASS

Usage class 2 is required in most cases. More severe exposure levels may require better risk coverage. Due to their natural durability, many species can easily meet the required usage class.

SPECIES

Acajou d'Afrique	Ekaba	Makoré
Akossika	Ekoune	Movingui
Andoung	Etimoé	Naga
Aniégré	Framire	Niangon
Bété	Gombé	Olon
Bomanga	Iatandza	Onzabili
Bossé clair	Iroko	Safukala
Bossé foncé	Kanda	Sapelli
Dibétou	Kosipo	Sipo
Douka	Koto	Tchitola
Ebiara	Limba	Tiama
	Longhi	Tola

Photo 27: Framework © P. Martin, ATIBT

Photo 28: Glued laminated timber posts, Aix-en-Provence train station © M. Vernay

1.2. GLUED LAMINATED TIMBER

DEFINITION AND ROLE

Glued laminated timber is a structural element made up of several wooden strips joined together and glued along their sides. This technique makes it possible to obtain heavy duty elements without any length limitations, for use in structures with extended sides. It makes it possible to produce straight poles and beams upon demand, either curved or with variable inertia. When the strips have equivalent properties, the glued laminated timber is said to be homogeneous. The overall performance of a beam can be improved during the production process by placing more resistant strips along the outer layers; this is referred to as variegated glued laminated timber. The glued laminated timber class is designated by two letters, GL (for glulam), followed by the bending strength value, followed by a letter indicating the type of glued laminated timber: h (homogeneous) or c (combined).
Example: GL 24 h.

STRESSES

Glued laminated timber mainly performs a mechanical function. As they are generally sheltered, posts and beams made with glued laminated timber can be subject to slight or occasional moisture (condensations, sprays, etc.).

REQUIRED PROPERTIES

The ratings and performances of glued laminated timber are described in standard EN 14080. The CE marking allows its performances to be displayed. Depending on the exposure and risk of biological degradation, an insecticidal fungicide treatment may be required if the natural durability is insufficient.

PRINCIPLES OF IMPLEMENTATION

Possible applications of glued laminated timber include a wide range of structures (poles, joists, beams, frameworks, etc.), as well as layout and decorative products (box girders, mezzanine structures, joinery, staircases, steps, trays, flat surfaces, furniture facades, etc.).
For species whose durability is insufficient, construction site cuts and trims must be retreated. Implementation recommendations are specifically described in standards NF-DTU 31.1 “traditional frameworks”, 31.2 “frames” and 31.3 “industrial frameworks”.

USAGE CLASS

Usage class 2 is required in most cases. More severe exposure may require better risk coverage for usage classes 3 and 4.

SPECIES

Akossika	Framire	Movingui
Aniégré	Iatandza	Naga
Bété	Iroko	Olon
Bomanga	Kanda	Sipo
Dabéma	Kosipo	Tchitola
Ekaba	Limba	Tola
Etimoé	Longhi	

1.3. FINGER JOINTS

DEFINITION AND ROLE

Glued laminated joints (or finger joints) are products that generally consist of 3 strips of joined or unjoined timber strips, and are glued along their sides. They can consist of 2, 4, 5, 7, 9 or 11 layers. The outer layers are said to have an inside face and an outside face, the inner layers are called intermediary or median layers.

There are several types of products on the market consisting of three layers, including:

- KKK: Three joined layers, joined at the face
- DKK: Two joined layers and one massive layer on the face
- DKD: Two massive outer layers and one median joined layer
- AKA: Two massive premium outer layers sorted according to colour with a joined median layer

Abbreviations used:
K = Keilgezinkte Strip/Joined strip; D = Durchgehende Strip/Whole strip; A = premium

There are no standardised standard dimensions, however the most common dimensions are:

- Length: from 60 cm to 6 m
- Width in mm: 65; 75; 86; 95; 105; 115; 120; 125; 145
- Thickness in mm: 63; 72; 84; 96

STRESSES

Finger joints are mainly used to produce joinery. Moreover, finger joints that are in use can be subject to significant temperature and humidity variations. The glue-lines can be exposed to bad weather.

REQUIRED PROPERTIES

The finger joints must be dimensionally stable, and ensure robustness of finishing work. They must be able to accommodate mechanical assemblies without any risk of alteration over time.

PRINCIPLES OF IMPLEMENTATION

Finger joints are designed for the making of finished products. For sheltered structures, D3 and C3 glues are sufficient and, for structures exposed to bad weather, D4 glues are required (see § 3.10 Gluing).

USAGE CLASS

Depending on the use, the required usage class varies between 1 and 3.

Photo 29: Finger joints © P. Martin, ATIBT

SPECIES

Bossé clair	Kosipo	Sipo
Bossé foncé	Okoumé	Tiama
Igaganga	Sapelli	

1.4. PLYWOOD, INSIDE FACE AND OUTSIDE FACE

DEFINITION AND ROLE
Plywood consists of a panel made of veneers obtained by rotary cutting or slicing. The veneers are glued and stacked by crossing the fibre direction of each layer at a 90° angle with respect to the previous one, and then pressed together during the glue polymerisation process. The layers are referred to as such.
The inner and outer layers are always arranged symmetrically on either side of a central layer, so as to obtain an orthotropic* panel. The outer layers that make up the apparent surface of the plywood consist of the inside and outside faces. Commercially, plywood is designated by the timber species that constitutes the exterior faces (for example Okoumé-faced plywood).

STRESSES
The exterior layers support the plywood's aesthetics. Their appearance, their ability to receive a finish and their conferred durability are therefore major factors when selecting a species.

REQUIRED PROPERTIES
The performance of the glue-lines when the panels are being manufactured is qualified according to their resistance to moisture (see § 3.10 Gluing). All species that are suitable for veneering and gluing are suitable for the manufacture of plywood. Only certain applications, in which high durability or mechanical strength criteria are sought, require the selection of suitable species. The requirements are defined in standard EN 636. The aspect quality of the faces (exterior layers) is suitable for use. The panels can be classified according to the nature of the species and the presence of defects on the faces. For certain types of technical plywood, the aspects of the faces are defined by standard EN 635. The general aspect classification is established in accordance with ATIBT's "*Guide technique pour la commercialisation des placages tropicaux*" (Technical Guide for the Commercialisation of Tropical Veneers).


Photo 30: Different plywood compositions © M. Vernay


Photo 31: Inside and outside faces of plywood © M. Vernay

PRINCIPLES OF IMPLEMENTATION
Panels intended for indoor use do not impose any particular constraints during implementation.

USAGE CLASS
The quality of the bonding and the treatment applied to the veneers make it possible to obtain panels that can be used in the four main usage classes (class 1 to class 4).

SPECIES

Abura	Ekaba	Lotofa
Acajou d'Afrique	Ekoune	Makoré
Aiélé	Etimoé	Moabi
Ako	Eyong	Movingui
Akossika	Framire	Naga
Andoung	Gombé	Niangon
Aniégré	Iatandza	Okoumé
Ayous	Igaganga	Olon
Bété	Ilomba	Onzabili
Bomanga	Iroko	Ozigo
Bossé clair	Kanda	Safukala
Bossé foncé	Kondroti	Sapelli
Dabéma	Kosipo	Sipo
Diania	Kotibé	Tchitola
Dibétou	Koto	Tiama
Douka	Landa	Tola
Ebiara	Limba	
	Longhi	

1.5. PLYWOOD, INNER LAYERS

DEFINITION AND ROLE

Plywood is a material that consists of timber sheets arranged in several layers. These sheets, referred to as “layers”, are glued under pressure on top of one another. The layers are obtained using rotary cutting or slicing processes.
In addition to the plywood’s visible faces, referred to as the outer layers, the panel consists of inner layers. Each panel consists of a central layer, or median layer, called the core. The other layers are arranged symmetrically on both sides. The non-visible interior layers allow for the use of much less noble species than are used on the faces. Timber that is white, lightweight or has a few defects is generally used for this function.

STRESSES

The inner layers are mainly used for the mechanical performance of plywood. The loads they can support are either perpendicular to the panel, or in the plane of the panel (bracing). They are used in many indoor and outdoor areas and can be subject to highly variable levels of ambient moisture.

REQUIRED PROPERTIES

As is the case with plywood’s inside and outside faces, the quality of the bonding, the durability of the timber species making up the layers and the composition of the panels are the main criteria likely to modify the panels’ properties. As the inner layers are not visible, their appearance is of minor importance as long as the defects do not affect the mechanical properties.

PRINCIPLES OF IMPLEMENTATION

Panels intended for indoor use do not present any particular constraints during implementation. Plywood panels intended for outdoor use or used in humid environments must meet the requirements of standard EN 636.

USAGE CLASS

Subject to impregnability* and a suitable insecticidal fungicide treatment, species that are intended for the interior layers of plywood may be used in different usage classes.

SPECIES

Abura	Emien	Landa
Aiélé	Essessang	Limba
Ako	Etimoé	Lotofa
Andoung	Faro	Makoré
Aniégré	Framire	Moabi
Ayous	Fuma	Okoumé
Bomanga	Gombé	Olon
Bossé clair	Iatandza	Onzabili
Bossé foncé	Igaganga	Ozigo
Dabéma	Ilomba	Safukala
Diania	Iroko	Sapelli
Douka	Kanda	Tchitola
Ekaba	Kondroti	Tola
Ekoune	Kotibé	

Photo 32: Thick veneering for plywood cores
© M.Vernay

1.6. SLICED VENEERS

DEFINITION AND ROLE
Veneers obtained by slicing, or through the use of any machine capable of producing thin output. These veneers are produced into quarters, into half-quarters or into slab boards. They are intended for decorations, furnishings, parquetry, boating, industrial joinery, industrial and decorative panelling and marquetry. The thicknesses of the veneers vary between 6/10th and 3 mm of thickness.

STRESSES
The main manufacturing constraints appear during the drying and trimming processes.

REQUIRED PROPERTIES
The vocation of veneers is purely decorative and involves the orientation of the output with respect to the structure of the timber. Depending on the species, output into quarters makes it possible to obtain a specific mesh or ribbing from counter-threaded timber. The irregularities of the thread also make it possible to obtain different representations: wavy, rippled, draped, speckled, tracked and dappled. Singularities* of the burr, brush and bramble variety are particularly sought after for the production of decorative veneers.

PRINCIPLES OF IMPLEMENTATION
Given their fragility, veneers are stored in conditioned environments in order to limit the risks of cracks and degradation. Desiccation is the main threat to veneers before their implementation. The preparation, cutting and gluing of veneers involves techniques that are specific to marquetry.

USAGE CLASS
For use in cabinetmaking and decorations, usage classes 1 and 2 are sufficient.

Photo 33: Sliced veneers, dappled and ribbed © M. Vernay

SPECIES

Abura	Difou	Makoré
Acajou Cailcédrat	Douka	Mambodé
Acajou d'Afrique	Doussié	Moabi
Afrormosia	Ebiara	Movingui
Aiélé	Ekoune	Mukulungu
Ako	Essia	Mutenyé
Akossika	Etimoé	Naga
Andoung	Eyong	Niangon
Angueuk	Eyoum	Niové
Aniégré	Faro	Okoumé
Avodiré	Framire	Olon
Awoura	Gombé	Olonvogo
Ayous	Iatandza	Onzabili
Bété	Igaganga	Ovéngkol
Bilinga	Iroko	Pachy
Bodioa	Izombé	Padouk d'Afrique
Bomanga	Kanda	Pao rosa
Bossé clair	Kosipo	Sapelli
Bossé foncé	Kotibé	Sipo
Bubinga	Koto	Tchitola
Cordia d'Afrique	Landa	Tiama
Diania	Lati	Tola
Dibétou	Limba	Wengé
	Longhi	Zingana
	Lotofa	

2. EXTERIOR JOINERY (BUILDING FAÇADE)

2.1. CLADDING AND OUTER COATING

DEFINITION AND ROLE
Cladding is the dressing of exterior façades using solid timber boards - moulded or non-moulded - that are mechanically fixed onto a frame. It protects façades and contributes to the thermal insulation of buildings, while providing aesthetic facing that is capable of resisting external aggressions.

STRESSES
These coatings are of the self-supporting type and are not subject to any particular mechanical stresses. Climatic stresses vary depending on the orientation of the façades and have an impact on the subsequent maintenance.

REQUIRED PROPERTIES
Cladding boards are products that must have CE marking according to the requirements of standard EN 14915. Its usage requires highly stable timber. Manufacturing criteria require that the width of an exposed board be less than 7.5 times its thickness, see EN 13647. The profile of hardwood boards must comply with the requirements of standard EN 14951.

PRINCIPLES OF IMPLEMENTATION
The installation of cladding is done according to the requirements of the NF-DTU 41.2 standard. Most species require pre-drilling for their fastening. The implementation must respect spacing rules upon installation in order to prevent the occurrence of creeps and deformations.

USAGE CLASS
Usage class 3 is required in most cases.

SPECIES

Acajou d'Afrique	Ekoune	Movingui
Afrormosia	Etimoé	Mukulungu
Bilinga	Eyoum	Niangon
Bossé clair	Framire	Niové
Bossé foncé	Iatandza	Osanga
Dabéma	Ilomba	Ovéngkol
Difou	Kanda	Pachy
Douka	Kosipo	Tchitola
Doussié	Landa	Tiama
Ebiara	Limbali	Tola
Ekaba	Makoré	Wengé

Photo 34: Installation of timber cladding on a façade
© M. Vernay

Photo 35: Installation of timber cladding in a walkway
© M. Vernay

2.2. WINDOWS AND DOORS

DEFINITION AND ROLE
Doors and windows are joinery assemblies that provide a passage and closure between the interior and exterior of a building. The woodwork consists of a doorframe (fixed) that features a door block, a French window or a window. The fixed frame window that provides a link between the opening and the wall is called a chassis.

STRESSES
Due to its position, exterior joinery is exposed to two different climatic atmospheres. The sides of the leaves/casements and frames are subject to moisture variations and different temperatures between the interior and the exterior. The openings are mechanically solicited during opening/closing events and are subject to wind action.

REQUIRED PROPERTIES
These assemblies are characterised by an evaluation of their air and water tightness, and of their thermal and acoustic insulation. Commercially, two qualitative choices are available depending on the type of finishing that is planned: transparent or opaque. Ratings and performances of doors and windows are described in standard EN 14351; CE marking enables their performances to be displayed.
In France, the "AEV" classification lists the characteristics of joinery: airtightness, watertightness and wind resistance.

PRINCIPLES OF IMPLEMENTATION
The reference document for the implementation of exterior joinery is standard NF-DTU 36.1.

USAGE CLASS
The usage class required for joinery varies from class 3, for environments exposed to bad weather, to usage class 2, for sheltered environments.

SPECIES

Acajou d'Afrique	Ebiara	Makoré
Afrormosia	Ekaba	Mambodé
Andoung	Ekoune	Moabi
Angueuk	Etimoé	Movingui
Bété	Eyoum	Niangon
Bodioa	Framire	Niové
Bossé clair	Gombé	Osanga
Bossé foncé	Iatandza	Ovéngkol
Bubinga	Iroko	Pachy
Cordia d'Afrique	Izombé	Sapelli
Difou	Kanda	Sipo
Douka	Kosipo	Tchitola
Doussié	Kotibé	Tiama
	Landa	Tola
	Limbali	Wengé

Photo 36: Window with two casements © V. Pasquet, Menuiseries PASQUET

Photo 37: French window with two leaves © V. Pasquet, Menuiseries PASQUET

2.3. SCREEN WALLS AND SOLAR SHADING

DEFINITION AND ROLE
Screen walls are vertical constructive structures that enable a space to be closed off, separating it or dividing it. Screen walls are perforated assemblies that allow light and air to circulate.
Solar shading is a perforated horizontal or vertical system that is designed to filter light on a façade or on a floor surface.

STRESSES
In the case of solar shading, the timber is directly subject to bad weather. Depending on the installation system, solar shading is subject to creep deformation due to its own weight and to the alternating effects of moisture and thermal shocks. Screen walls are rigid joinery assemblies that are designed to withstand bad weather while remaining stable.

REQUIRED PROPERTIES
For these types of products, the primarily expected timber qualities are stability and durability. Timber species characterised by medium density and a low risk of cracking* are preferred.

PRINCIPLES OF IMPLEMENTATION
Implementation must allow for shrinkage and swelling movements in the widest elements, without hindering the structures' aesthetics or solidity. The assemblies must minimise water infiltration. The mounting distance between support points must be correctly defined in order to limit the risk of creep deformation.

USAGE CLASS
Usage class 3 is required in the event of perfect drainage or class 4 in the event of prolonged exposure to moisture.

SPECIES

Bété	Iroko	Moabi
Bossé clair	Izombé	Niangon
Bossé foncé	Kanda	Osanga
Difou	Limbali	Pachy
Douka	Lotofa	Padouk d'Afrique
Doussié	Makoré	Tola

Photo 38: Separating screen wall © kai4107

Photo 39: Solar shading façade made with Iroko © M.Vernay

2.4. SHUTTERS AND CLOSURES

DEFINITION AND ROLE

Shutters and closures are movable closure elements that protect the bay windows of a façade. Timber shutters generally come in two varieties: with solid boards or with louvered boards. Shutters complete the exterior joinery of building façades. They provide security by providing protection from entry and by blocking the view from outside the building. Shutters also enable one to regulate aeration, ventilation and light. Due to their external position on bays, they also protect joinery.

STRESSES

Shutters are subject to both moisture and drying on their faces in both an uneven and alternating manner, depending on the orientation of the façades as well as the positioning of the shutters. The shutters should not deform under their own weight.

REQUIRED PROPERTIES

The shutters must be resistant in order to fulfil their protective function. They must be able to protect joinery from bad weather without the risk of deformation. Shrinkage and swelling phenomena must be kept under control. The timber must not be too dense, for reasons involving convenience and resistance to the use of fastening and rotating elements.

PRINCIPLES OF IMPLEMENTATION

The timber used to make the boards is shaped so as to ensure a leak-tight assembly that is capable of handling the dual phenomena of shrinkage and swelling. The rigidity and squareness of the panels must be perfect in order to avoid collapses. Runoff water on the façades must not result in infiltrations, so the upper part of the shutters must be protected by an effective system or type of assembly. Mounting based on mounts and rails, or bars and sashes, must ensure that the flaps remain both rigid and even. The timber can be protected using a finish and with regular care.

USAGE CLASS

Usage class 3 is representative of these structures, which, due to their position, are exposed to bad weather but have the possibility of drying between two successive occurrences of moisture.

SPECIES

Acajou d'Afrique	Ekaba	Landa
Afrormosia	Ekoune	Makoré
Andoung	Etimoé	Mambodé
Bété	Framire	Movingui
Bossé clair	Gombé	Niangon
Bossé foncé	Iatandza	Sapelli
Cordia d'Afrique	Iroko	Sipo
Douka	Izombé	Tchitola
Ebiara	Kanda	Tiama
	Kosipo	Tola

Photo 40: Louvered shutters © V. Pasquet, Menuiseries PASQUET

Photo 41: Solid shutters© M. Vernay

3. CARPENTRY AND INTERIOR FITTINGS

3.1. WOODEN FLOORS

DEFINITION AND ROLE
A wooden floor is a set of planks that make up a construction's wooden floor cover. The various types of wooden floors are distinguished by their composition (solid or laminated) and by their presentation (single-plank or multi-plank).

STRESSES
The floorboard must withstand conventional usage loads, indentation* and occasional occurrences of moisture. French rules define several usage classes related to the frequency and intensity of service on these floor covers.

REQUIRED PROPERTIES
Solid wooden floors vary in thickness from 12 to 23 mm and laminated planks and panels have a cladding layer (min. of 2.5 mm thickness) equal to the wear layer. The choice of wooden flooring must be defined according to the type of use (see § 3.2 Hardness). African timber mainly covers the two superior hardness classes. Wooden floor planks are products that require CE marking according to the specifications of the following standards: EN 13226, EN 13228, EN 13629 and EN 13990.

PRINCIPLES OF IMPLEMENTATION
The wooden floor planks can be nailed, glued or installed in a floating manner. The implementation recommendations are described in the respective Building Codes: 51.1, 51.2 and 51.11.

USAGE CLASS
This use requires a usage class of 2 and above.

SPECIES

Acajou Cailcédrat	Eyong	Mukulungu
Afrormosia	Eyoum	Mutenyé
Akossika	Framire	Naga
Andoung	Iatandza	Niangon
Awoura	Igaganga	Niové
Bété	Iroko	Okan
Bilinga	Izombé	Osanga
Bomanga	Kanda	Ossoko
Bossé clair	Kosipo	Ovéngkol
Bossé foncé	Kotibé	Ozigo
Bubinga	Landa	Ozouga
Diania	Lati	Pachy
Difou	Longhi	Padouk d'Afrique
Douka	Lotofa	Safukala
Doussié	Makoré	Sapelli
Ebiara	Mambodé	Tiama
Etimoé	Moabi	Wengé
	Movingui	

Photo 42: Wooden floors
© Y. Panaget, DESIGN PARQUET

Photo 43: Wooden floors
© Y. Panaget, DESIGN PARQUET

3.2. INTERIOR STAIRCASES

DEFINITION AND ROLE
An interior staircase is a constructed assembly that consists of a series of steps that link two different levels. Its structure is either integrated into the wall that supports it or it is self-supporting. The staircase generally consists of stringboards, steps, risers and ramps.

STRESSES
Staircases are subject to occasional, mobile and variable loads depending on the intensity of the passage. The steps must have good resistance to indentation* and to wear caused by friction.

REQUIRED PROPERTIES
The timber required for the manufacture of staircases must be stable, mechanically effective and have an appropriate level of hardness. It must feature a non-slip surface condition under all circumstances.

PRINCIPLES OF IMPLEMENTATION
Staircases and guardrails are subject to the construction rules described in standard NF-DTU 36.3. The assembly systems must demonstrate a high level of mechanical resistance.

USAGE CLASS
All of the elements fall under the scope of usage class 2.

SPECIES

Acajou Cailcédrat
Afrormosia
Akossika
Andoung
Awoura
Bomanga
Bubinga
Diania
Difou
Douka
Doussié
Ebiara
Etimoé
Framire
Iatandza
Igaganga
Iroko
Izombé
Kanda
Kosipo
Kotibé
Landa
Limba
Limbali
Longhi
Lotofa
Makoré
Mambodé
Moabi
Movingui
Mutenyé
Naga
Niangon
Niové
Osanga
Ovéngkol
Ozigo
Pachy
Padouk d'Afrique
Sapelli
Sipo
Tiama

Photo 44: Staircase © P. Garcia, MD CREATION

3.3. DOORS AND DOOR FRAMES

DEFINITION AND ROLE

Doors are openings or bays that enable communication and movement within buildings or premises. These bays are equipped with a closing system that consists of a casing and they can accommodate a door. These structures can include one or more leaves secured to rotation devices. The door frames, also referred to as chassis, make up the frames that support and accommodate these leaves. They provide the link between the door and the partition or wall.

STRESSES

The door frames' mounts accommodate the fasteners (hinges or split hinges) of the leaves they support. The leaves are elements that are designed to prevent any air or noise from penetrating. In some specific cases, doors may be required to be "fireproof" or "flameproof"; the density of the timber that is used is therefore quite important.

REQUIRED PROPERTIES

The timber of door frames can meet two different qualitative choices depending on whether they are visible joinery or are covered with an opaque finish. The choice of the species can be purely aesthetic, depending on the constructive option that is chosen.
The choice of "joinery" or its equivalent is required for doors made of solid timber. Many doors are constructed using plywood in order to make panels.

PRINCIPLES OF IMPLEMENTATION

The implementation of interior joinery is described in standard NF-DTU 36.2. The term "door frames" includes everything relating to interior decorating and cladding: frames, pre-frames, chassis, assemblies, counter-assemblies and fixed frames. The leaves or doors are movable elements that are designed to close off a passage. The elements must therefore be adjusted with precision.

USAGE CLASS

Door frames are in usage class 2 in order to take account of the risk of accidental humidification of the parts in contact with the ground. The interior doors can be made using low-durability timber, accepted for usage class 1.

SPECIES

Abura
Acajou Cailcédrat
Acajou d'Afrique
Afrormosia
Aiélé
Ako
Akossika
Andoung
Angueuk
Aniégré
Avodiré
Awoura
Ayous
Bété
Bilinga
Bodioa
Bomanga
Bossé clair
Bossé foncé
Bubinga
Cordia d'Afrique
Diania
Dibétou
Difou
Douka
Doussié
Ebiara
Ekaba
Ekoune
Emien
Etimoé
Eyong
Faro
Framire
Gombé
Iatandza
Igaganga
Ilomba
Iroko
Izombé
Kanda
Kondroti
Kosipo
Kotibé
Koto
Landa
Lati
Limba
Limbali
Longhi
Lotofa
Makoré
Mambodé
Moabi
Movingui
Mutenyé
Naga
Niangon
Niové
Okoumé
Olon
Olonvogo
Onzabili
Osanga
Ossoko
Ovéngkol
Ozigo
Pachy
Padouk d'Afrique
Safukala
Sapelli
Sipo
Tchitola
Tiama
Tola
Wengé

Photo 45: Interior door © V. Pasquet, Menuiseries PASQUET

3.4. MOULDING

DEFINITION AND ROLE
Moulding is a timber slat on which a profile has been made, for aesthetic purposes. Mouldings are used as part of frames, frameworks, panel decorations and for various joint covers.

STRESSES
Due to its position, a moulding is subject to little physical or mechanical stress. A moulding is normally not exposed to moisture. Only insecticide treatments can be considered for the most sensitive timber species if there is a proven risk to certain exposures.

REQUIRED PROPERTIES
The timber must exhibit a perfect surface condition after its processing in a moulder. It should have straight thread and not have any fibres that are likely to rise up. The moulding should be easy to sand and combine well with tinted, varnished and painted finishes. Timber with fine grain provides the best surface appearance and the best polish.

PRINCIPLES OF IMPLEMENTATION
Mouldings are marketed in standard lengths intended for recutting. For framing work, mouldings are usually cut with mitre cuts.

USAGE CLASS
Most species intended for the production of mouldings are of low durability, or even non-durable, in terms of their resistance to biological degradation agents. An insecticide treatment may be necessary in the event of risk. Usage class 1 is accepted for mouldings.

SPECIES

Abura	Essessang	Limba
Ako	Etimoé	Niangon
Akossika	Framire	Okoumé
Aniégré	Fuma	Olon
Avodiré	Gombé	Olonvogo
Ayous	Igaganga	Onzabili
Bété	Ilomba	Ossoko
Diania	Izombé	Sipo
Ekaba	Kondroti	Tola
Ekoune	Koto	
Emien	Lati	

Photo 46: Mouldings © E. Groutel, WALE

Photo 47: Panelling © SFIO CRACHO

3.5. INTERIOR PANELLING AND CLADDING

DEFINITION AND ROLE
Panelling is interior cladding that consists of wooden boards, generally nested with grooves and tabs. These panels - sometimes referred to as "woodwork" - constitute a decorative covering.

STRESSES
The panel boards (made with panelling boards) are self-supporting. The relatively close fastening points on the supports eliminate the main risks associated with the material's behaviour, especially deformations by buckling

REQUIRED PROPERTIES
Panelling boards must be stable for use in thin situations. The timber is either selected for its natural aesthetic appearance or for its ability to receive a finish.

PRINCIPLES OF IMPLEMENTATION
Panelling in the form of boards can be laid horizontally or vertically, and even obliquely. In the case of horizontal installations, the edge equipped with a tab must be oriented upwards so that any condensation may flow out.

Installation rules according to standard NF-DTU 41.2 help prevent construction errors that could lead to premature deterioration. Installation is carried out on battens using staples, nails or screws. The suitability of the timber for this type of mounting should be verified and its implementation should be adapted.

USAGE CLASS
Given the sheltered situation and the absence of risks of moisture, usage class 1 may be accepted for these structures. Insecticide treatments may be necessary in the event of risk.

SPECIES

Abura	Difou	Longhi
Acajou Cailcédrat	Douka	Lotofa
Acajou d'Afrique	Doussié	Makoré
Afrormosia	Ebiara	Mambodé
Aiélé	Ekaba	Moabi
Ako	Ekoune	Movingui
Akossika	Etimoé	Mutenyé
Andoung	Eyong	Naga
Avodiré	Framire	Niangon
Awoura	Gombé	Niové
Ayous	Iatandza	Okoumé
Bété	Ilomba	Olon
Bodioa	Iroko	Olonvogo
Bomanga	Izombé	Ossoko
Bossé clair	Kanda	Ovéngkol
Bossé foncé	Kondroti	Ozigo
Bubinga	Kosipo	Safukala
Cordia d'Afrique	Kotibé	Sapelli
Diania	Koto	Sipo
Dibétou	Landa	Tiama
	Lati	Tola
	Limba	Wengé
	Limbali	Zingana

3.6. LAYOUT AND FURNISHINGS

DEFINITION AND ROLE
Timber intended for layouts mainly involves structures and the cladding of interior joinery elements. It is also used in combination with plywood panels, particle boards (chipboard) and medium density fireboards. The timber is often concealed with cladding or a finish. The pieces of timber rarely play a major mechanical role, they are basically light structures. In furnishings, furniture structures are made from timber cut into spurs.

STRESSES
Only the destination and the distribution of the structures within a home can modify durability requirements (variations of surrounding climatic conditions). Excessive moisture variations can cause, for example, shrinkage or swelling in solid timber and cause inconvenience to users.

REQUIRED PROPERTIES
Many species can be suitable for layouts and furnishings. There is practically one favoured use for each type of species depending on whether they are for light structures or for cladding implemented in various configurations. The timber must be stable for it to be assembled and glued. The ability to receive a finish must be taken into account as well as the colour homogeneity of the selected species in the event that a non-opaque product is applied.

PRINCIPLES OF IMPLEMENTATION
Timber moisture must be controlled and adapted to the conditions of the implementation environment. The timber must be perfectly stabilised. For hard timber, the principle of pre-drilling for screws must be considered in order to avoid the risk of splinters or cracks on the assembled elements.

USAGE CLASS
Usage classes 1 and 2 represent the majority of service situations.

Photo 48: Kitchen furnishings © CIB

SPECIES

Abura
Acajou Cailcédrat
Acajou d'Afrique
Afrormosia
Aiélé
Ako
Akossika
Andoung
Aniégré
Avodiré
Awoura
Ayous
Bilinga
Bomanga
Bossé clair
Bossé foncé
Bubinga
Cordia d'Afrique
Dabéma
Diania
Dibétou
Difou
Douka
Doussié
Ebiara
Ekaba
Ekoune
Emien
Essessang
Etimoé
Eyong
Faro
Framire
Fuma
Gombé
Iatandza
Igaganga
Ilomba
Iroko
Izombé
Kanda
Kondroti
Kosipo
Kotibé
Koto
Landa
Lati
Limba
Longhi
Lotofa
Makoré
Mambodé
Moabi
Movingui
Mutenyé
Naga
Niangon
Niové
Okoumé
Olon
Olonvogo
Onzabili
Ossoko
Ovéngkol
Ozigo
Pachy
Safukala
Sapelli
Sipo
Tchitola
Tiama
Tola
Wengé
Zingana

3.7. FURNITURE AND CABINETMAKING

DEFINITION AND ROLE

Furniture refers to the movable elements of a home, an office or a place of storage. This therefore includes all of the elements linked to the comfort of places where people spend time. Furniture can be both functional and decorative. Cabinetmaking refers to the furniture obtained by combining a light timber structure or frame with panels (usually made with veneers). Also associated with cabinetmaking is marquetry work, which involves the small-sized objects that embellish human environments.
For marquetry and cabinetmaking work, hard and figured timber species are particularly appreciated.

STRESSES

Furniture may have wearing parts due to friction (ex: drawers). The elements that are most sensitive to deterioration are the feet of furniture, which may be subject to occasional moisture near the floor area. Furniture is also likely to receive shocks; the surfaces must therefore be resistant or reinforced by a hardener in the event of repeated stress (table tops, for example).

REQUIRED PROPERTIES

Stable wood is sought that can easily be shaped and receive a finish. The grain of the wood and the quality of its thread (straight or counter-threaded) play a role in the final visual aspect. It is for this reason that cabinetmaking is sometimes favoured for the making of high-end furniture. Veneering obtained by rotary cutting or slicing, make it possible to produce figurations and patterns that cannot be obtained using solid timber.

PRINCIPLES OF IMPLEMENTATION

The building and assembly of solid timber furniture, in whole or in part, requires precise machining tools and proven know-how. The same is true of the cabinetmaking craft, in which the use of veneered or marquetry panels requires solid knowledge. In all cases, craftsmen work with perfectly stabilised timber in controlled climatic environments. Depending on the aspect that is sought, the selected timber species may display different meshes, figurations, colours and grains.

USAGE CLASS

With the exception of structural parts that may be exposed to accidental humidity, all species covering usage classes 1 and above may be suitable depending on the element under consideration.

SPECIES

Abura
Acajou Cailcédrat
Acajou d'Afrique
Afrormosia
Akossika
Aniégré
Avodiré
Awoura
Bété
Bilinga
Bomanga
Bossé clair
Bossé foncé
Bubinga
Cordia d'Afrique
Dibétou
Difou
Douka
Doussié
Ebène d'Afrique
Ebiara
Etimoé
Iatandza
Iroko
Izombé
Kanda
Kosipo
Kotibé
Longhi
Makoré
Mambodé
Moabi
Movingui
Mutenyé
Naga
Niangon
Niové
Ovéngkol
Padouk d'Afrique
Pao rosa
Sapelli
Sipo
Tiama
Wengé
Zingana

Photo 49: Chair © M. Vernay

4. OUTDOOR EQUIPMENT - RECREATION

4.1. EXTERIOR STAIRCASES AND GUARD RAILINGS

DEFINITION AND ROLE
A staircase is an assembled construction that is intended for the vertical passage of people. It consists of a series of steps and usually has a guardrail. It allows one to access one floor from another one or to move to a level with a significant difference in height in a more or less linear manner. The guardrail is generally a perforated partition that ensures the safety of the people who walk up or down the stairs. The upper handrail provides support for its users.

STRESSES
Located outside, a staircase exposed to bad weather supports occasional loads that are mobile and variable, depending on the intensity of each passage.

REQUIRED PROPERTIES
In principle, a staircase is an elevating work that must be resistant over time. The timber that is used must be of high durability and must demonstrate very high resistance in terms of its assemblies. The surface finish of the steps must be non-slip and non-slippery under all weather conditions. The timber must demonstrate proper hardness with respect to indentation* and to the wear caused by friction (stemming from regular use).

PRINCIPLES OF IMPLEMENTATION
Stairs and guard railings are subject to strict and precise construction rules. The construction of assemblies must limit, and even eliminate, any risk of infiltration or trapped water. Assemblies by bolting are preferable. Drainage of horizontal surfaces, especially steps, must be effective and compatible with the anti-slip system. Elements at the base that are exposed in terms of "open edges" must be equipped with a water evacuation system (such as a "water drop" system).

USAGE CLASS
All of the elements fall under the scope of usage class 4.

SPECIES

Afrormosia	Eveuss	Okan
Alep	Eyoum	Osanga
Azobé	Kanda	Ovéngkol
Bilinga	Landa	Ozouga
Congotali	Makoré	Pachy
Difou	Moabi	Padouk d'Afrique
Douka	Mukulungu	Tali
Doussié	Niové	

Photo 50: Exterior staircase © WIJMA

4.2. SINGLE-LEVEL TERRACES AND POOL AREAS

DEFINITION AND ROLE
These are exterior arrangements that consist of timber boards intended to constitute a deck for the reception and passage of people. When the height of the structure exceeds 1 m from the ground, these structures are described in the following section: 4.3 Elevated terraces, balconies and corridors.

STRESSES
Due to their horizontal position, the deck elements are subject to severe exposure to bad weather: the effects of water, UV rays, cold and heat. For decks situated next to pools, the timber must be able to withstand splashes of water, chlorine and salt.

REQUIRED PROPERTIES
The properties of decking boards that can be used in ground level terraces are described in standard NF B 54040. The boards must have a surface condition that guarantees the safety of users in a lasting manner.

PRINCIPLES OF IMPLEMENTATION
These structures are the subject of standard NF-DTU 51.4, which outlines the various situations that can be encountered when constructing a terrace.

USAGE CLASS
Two service situations are to be considered, distinguishing, on the one hand, those elements that will not have any contact with the ground or with a prolonged source of moisture (usage class 3) and, on the other hand, the exterior timber that will touch the ground or prolonged source of moisture (usage class 4).

SPECIES

Afrormosia	Doussié	Monghinza
Alep	Eveuss	Mukulungu
Angueuk	Eyoum	Niové
Azobé	Iatandza	Okan
Bété	Iroko	Osanga
Bilinga	Izombé	Ovéngkol
Bossé clair	Kanda	Pachy
Bossé foncé	Landa	Padouk d'Afrique
Congotali	Limbali	Tali
Difou	Makoré	
Douka	Moabi	

Photo 51: Terrace
© PARQUETERIE AIXOISE

Photo 52: Profiled terrace boards
© M. Vernay

Photo 53: Structure© WIJMA

4.3. ELEVATED TERRACES, BALCONIES AND CORRIDORS

DEFINITION AND ROLE
This type includes all of the exterior installations that are at least 1 m above the ground, usually adjacent to a façade or in between two buildings, consisting of timber boards that form a deck for the reception and passage of people.

STRESSES
Due to their horizontal position, the deck elements are subject to severe exposure to bad weather (the effects of water, UV rays, cold and heat).

REQUIRED PROPERTIES
The properties of the decking boards that can be used in these structures are described in standard NF B 54040. The boards must have a surface condition that guarantees the safety of users in a perennial manner. The ledger board on which the boards are screwed must meet the requirements of standard EN 14081.

PRINCIPLES OF IMPLEMENTATION
These structures are considered to be timber structures and are therefore subject to standard NF DTU 31.1. It is necessary to verify the compatibility of the timber that is used with the nature of the nearby materials in order to avoid reactions (such as façade plaster, which can react when it comes into contact with the tannins of certain timbers).

USAGE CLASS
For reasons linked to user safety, all timber used for these works must cover usage class 4

SPECIES

Afrormosia	Eveuss	Okan
Alep	Eyoum	Ozouga
Azobé	Kanda	Pachy
Bété	Landa	Padouk d'Afrique
Bilinga	Makoré	Tali
Congotali	Moabi	Wamba
Difou	Monghinza	
Douka	Mukulungu	
Doussié	Niové	

4.4. SHELTERS, OUTDOOR FURNITURE AND PLAYGROUNDS

DEFINITION AND ROLE

There are two types of outdoor equipment that are intended for recreation outside:

- Fixed equipment such as recreational, picnic and play areas, which are generally made of hardwood for reasons linked to stability and durability over time. In principle, they cannot be removed, are fixed to the ground and are often located in areas with medium to high climatic condition exposure levels.
- Mobile equipment such as garden furniture, which must be lighter in design in order to remain transportable and possibly foldable.

All of these structures are designed to accommodate people or to be in direct contact with them.

STRESSES

The service situations (of these structures) expose them to bad weather, and in particular to contact with the ground and water. Moreover, this type of equipment is solicited by occasional loads and is therefore subject to risks of breakage in the event of heavy stress.

REQUIRED PROPERTIES

Contact with people requires the use of timber whose behaviour and surface appearance must remain constant over time. The timber must have a low aptitude to crack* or break. The surface finish must not degrade and must not present any risk to users. Likewise, the material must demonstrate appropriate resistance against shocks and malicious acts. Resistance against biological degradation by rot must be also good.

PRINCIPLES OF IMPLEMENTATION

The installation of these structures must be done with care in order to avoid the risk of injury due to the presence of pointed parts or sharp edges that have not been chamfered. The design of the assemblies must allow for the perfect flow of rainwater. It is advised that assemblies using bolts or screws be used rather than assemblies that rely on timber cuts (tenons / mortises). The horizontal sections should be designed with louvring in order to allow rainwater to flow off (table top, bench seat and chair). The quality of the finish and its maintenance play an important role in maintaining the aesthetic appearance of the structures. A film-forming finish quickly becomes a source of water trapping in the event of poor maintenance.

USAGE CLASS

These structures predominantly fall under usage class 4. Only sheltered elements can use timber having lower durability.

SPECIES

Afrormosia	Douka	Niové
Angueuk	Doussié	Okan
Bilinga	Iatandza	Pachy
Bossé clair	Izombé	Padouk d'Afrique
Bossé foncé	Kanda	Tali
Difou	Makoré	

Photo 54: Wing chair © M. Vernay

Photo 55: Play area © P. Martin, ATIBT

4.5. GATES

DEFINITION AND ROLE
A gate is a single or double door that delimits a property from the exterior. The dimension of the leaves is variable.

STRESSES
There are two different types of stress:
- the gate is totally or partially sheltered by a canopy or porch. It is subject to bad weather and frequent moisture, but the timber elements are able to dry between two onsets of moisture. It is an above ground structure whose design must feature meticulous water drainage.
- the unsheltered gate is subject to greater exposure to bad weather and prolonged moisture. The assemblies are often non-draining and the structural parts are close to the ground or in contact with runoff water.

REQUIRED PROPERTIES
The timber must be able to resist the various biological degradation agents, especially lignivorous fungi in the case of exposed situations.

PRINCIPLES OF IMPLEMENTATION
In principle, the structure's construction must enable the permanent drainage of all the faces of the elements that make up the gate. In unsheltered, stagnating water is not allowed. The choice of the species intervenes in terms of the structure's own weight. High-density species are to be avoided due to the loads and efforts imposed on the rotational supports and components.

USAGE CLASS
A sheltered gate falls under usage class 3.
A gate exposed to bad weather falls under usage class 4.

SPECIES

Afrormosia	Doussié	Okan
Angueuk	Iatandza	Pachy
Bilinga	Izombé	Padouk d'Afrique
Bossé clair	Kanda	Tali
Bossé foncé	Makoré	
Difou	Niové	
Douka	Oboto	

Photo 56: Gate © M. Vernay

Photo 57: Gate © F. Codron, PELTIER BOIS

4.6. VISUAL BARRIERS AND WINDBREAK PANELS, PERGOLAS

EFINITION AND ROLE
Visual barriers and windbreak panels are vertical construction elements designed to protect certain places from view and from the wind. Pergolas are mainly intended to offer protection from the sun.

STRESSES
The panel design must take into account the various situations of use:
- panel close to or in contact with the ground and water,
- vertical panel or filling element subject to bad weather, which encourages the formation of cracks*. These panels can be likened to cladding exposed on both sides.

REQUIRED PROPERTIES
The timber must demonstrate good stability, have straight and low-split thread and offer a high degree of resistance to rot and dry wood insects.

PRINCIPLES OF IMPLEMENTATION
Windbreak panels and visual barriers do not require the use of heavy duty sections. They must be lightweight, flexible and able to resist climatic constraints. A louvred assembly in the form of braiding or duckboard is recommended, in order to mitigate the effects of the wind without blocking its passage.
The wood of pergolas must be correctly sized in order to limit the risk of creep deformation.

Photo 58: Kastrup wind barrier © WIJMA

USAGE CLASS
Elements that are close to or in contact with the ground fall under usage class 4.
Perfectly drained vertical filling elements fall under usage class 3.

SPECIES

Afrormosia	Douka	Niové
Angueuk	Doussié	Oboto
Bilinga	Iatandza	Okan
Bossé clair	Izombé	Pachy
Bossé foncé	Kanda	Padouk d'Afrique
Difou	Makoré	Tali

Photo 59: Pergola © Santiago Cornejo

5. INDUSTRIAL USAGE AND HEAVY WORK

5.1. HYDRAULIC WORKS IN A SUBMERGED MARINE ENVIRONMENT

DEFINITION AND ROLE

These works apply to all of the constructions carried out in maritime and port environments and in lagoon zones. Maritime constructions are defined as works in which a substantial part of the structure is permanently in contact with sea water or the seabed: landing stages, pontoons, wharf defences, breakwaters, etc. The platforms of pontoons and landing stages are designed to accommodate the public and boaters. They are wooden coverings intended to allow users to walk about (they are not in direct contact with water).

STRESSES

These structures are subject to permanent moisture and undergo mechanical stresses linked to the function they provide. A landing stage protects a sea area from the effects of waves and swells, and it mitigates the amplitude of waves. A pontoon which allows access to areas above the marine environment is swayed

Photo 60: Landing stage © M. Vernay

by the tides and potentially the shocks of boats. The wharf defences must be able to resist the shocks and friction of ships. The decks must be able to withstand vertical loads and the shocks caused by the handling and passage of the pontoon's users.

REQUIRED PROPERTIES

Submerged timber must be sufficiently durable to withstand attacks by marine borers and certain wood boring molluscs. They must be dense and hard to withstand shocks and other mechanical stresses. The decking timber must be mechanically effective and have excellent preservation qualities in order to face bad weather and the proximity of sea water. The timber boards must have low-split thread and demonstrate good resistance against shocks.

PRINCIPLES OF IMPLEMENTATION

The heavy structures of these marine works are assembled using simple techniques involving strutted and bolted parts. Other techniques based on woodworking (tenon, mortise, half-wood, etc.) are not retained for reasons linked to sturdiness and durability.

USAGE CLASS

Timber that is permanently immersed in marine or brackish waters falls under usage class 5. Tidal zones, revealed by low tides, and structural parts installed outside of water are not considered as falling under usage class 5. However, for all uses that are not permanently immersed, usage class 4 is required because of the risk of attack by lignivorous fungi.

SPECIES

Azobé	Monghinza	Sougué
Bilinga	Mukulungu	Wamba
Congotali	Okan	
Moabi	Padouk	

Photo 61: Wharf defences © WIJMA

5.2. STRUCTURES AND BRIDGES IN CONTACT WITH SOIL OR FRESH WATER

DEFINITION AND ROLE

Bridges and footbridges enable communication between two zones separated by an obstacle, a watercourse or a depression.

Photo 62: Bridge © WIJMA

Photo 63: River embankment © WIJMA

STRESSES

Structures located outside that are not sheltered and located in wet areas that are near or in contact with the ground.

REQUIRED PROPERTIES

The timber must be highly resistant to biological degradation agents, especially rot fungi and termites in affected areas. Depending on the mechanical performances that are sought, the timber that is used must meet the project's requirements.

PRINCIPLES OF IMPLEMENTATION

Permanent or prolonged contact with the ground or a source of humidity should be considered in terms of a targeted performance regarding the lifetime of the structure. To this end, measures can be taken to limit the risk of degradation development: improved drainage, minimal cuts to avoid water migration at the tips of the timber and a limited number of holes or assemblies that could become water retention or infiltration points.
Many species have the durability, hardness and mechanical strength characteristics that are recognised for this type of use.

USAGE CLASS

All species eligible for use in contact with soil or freshwater that fall under usage class 4 may be associated with the service life defined by the nature of the work.

SPECIES

Alep	Doussié	Ozouga
Azobé	Eveuss	Pachy
Bété	Eyoum	Padouk d'Afrique
Bilinga	Makoré	Tali
Congotali	Moabi	Wamba
Coula	Mukulungu	
Difou	Niové	
Douka	Okan	

5.3. ACOUSTIC BARRIERS IN URBAN AREAS ALONG RAILROADS AND HIGHWAYS

DEFINITION AND ROLE
Acoustic barriers are systems that are designed to reduce noise emanating from road or rail traffic. An acoustic barrier limits the scope of nuisances by deviating or absorbing the direct transmission of airborne noise coming from vehicles or from rolling railway equipment. The construction generally consists of foundations, poles and panels as well as other materials whose assembly makes it possible to mainly focus on acoustic performances.

STRESSES
Given their exposure within road and rail infrastructures, structures and panels assembled in the form of barriers or screens must meet many criteria. The hold of the barriers and their mechanical stability must be ensured over time so as to withstand the stresses associated with wind loads, the dynamic pressures caused by traffic, impacts caused by various projections, etc.

Photo 64: Absorbent acoustic barriers along a railway © M. Vernay

Photo 65: Absorbent acoustic barriers along a railway © M. Vernay

REQUIRED PROPERTIES
The mechanical resistance class of structural timber must be greater than or equal to D 30. The components of timber acoustic barriers are generally used in situations requiring usage class 4, due to their exposure while in service. In termite zones, the pieces of timber must either be naturally durable with respect to termites or they must have undergone an appropriate treatment. For certain weatherproof destinations (tunnels, roofing works, etc.), timber protection by fireproofing* can be recommended. If a treatment is planned in the wood mass, the timber must be impregnable. Barrier performance is evaluated according to standards EN 14389, EN 1793 and EN 1794.

PRINCIPLES OF IMPLEMENTATION
The panels must be designed to allow water drainage. Particular attention must be paid to foundations and assemblies, given the efforts they have to bear. The specifications are detailed in various professional guides, including the "Guide for the design and construction of timber acoustic barriers" by the FIBC (Federation of Timber Industries and Construction).

USAGE CLASS
The parts that make up acoustic barriers predominantly fall under usage class 4. Some durability 2 species can be used in the upper parts of the panels (coping) or for lateral lathing to protect absorbent material.

SPECIES

Alep	Coula	Monghinza
Azobé	Difou	Pachy
Bété	Doussié	Padouk d'Afrique
Bilinga	Eveuss	
Congotali	Eyoum	

5.4. SLEEPERS AND DUNNAGE TIMBER

DEFINITION AND ROLE
"Sleepers" mainly refer to the timber pieces that are intended for use under rails. Railroad sleepers are distinguished from appliance and shunting timber. In both cases, they are heavy duty timber that is intended to support rails and rolling stock. The sleepers ensure contact by distributing support efforts along the ground and they maintain the spacing between the rails. The filling and wedging within the ground is carried out using ballast.

Photo 66: Boat slips packaged for maritime transport © M. Vernay

This category also applies to dunnage timber used in the navy to support ships when they are pulled out of the (aground and dry docks). These square* timber pieces with precise sections are referred to as "boat slips".

STRESSES AND EXPOSURE
Sleepers are used in extreme conditions that vary depending on the geographical area and the climate, but they are always laid down on draining ground. They support very strong forces and they must absorb the deformations of the metal rails, as well as vibrations and friction.
Boat slips are mainly used in transverse compression. In general the wood must be delivered green, i.e. above the Fibre Saturation Point, in order to limit the dimensional variations that may occur during its use during the dunnage of ships.

REQUIRED PROPERTIES
The pieces must have a heavy duty section and be cut in such a way as to limit deformations. The timber must be highly durable, have hardness properties that are adapted to the stresses when in use and not be subject to cracking from vibrations and vertical and horizontal loads.

PRINCIPLES OF IMPLEMENTATION
Implementation principles are typically outlined in specific specifications provided by a railway or maritime company.

USAGE CLASS
Sleepers and dunnage timber fall under usage class 4.

SPECIES

Alep	Eveuss	Okan
Azobé	Eyoum	Osanga
Bilinga	Moabi	Ozouga
Congotali	Monghinza	Padouk d'Afrique
Coula	Mukulungu	Tali
Difou	Niové	

Photo 67: Boat slips © F. Codron, PELTIER BOIS

Photo 68: Sleepers of a shunting line © WIJMA

5.5. INDUSTRIAL FLOORS AND HEAVY FRAMEWORK

DEFINITION AND ROLE
These products are structural elements designed to receive heavy loads and undergo significant stresses linked to the use of equipment and machines. These structures and floors are found in agricultural or industrial buildings that are mostly semi-open or partially protected. The floors can be used by transport machines and converted into storage and handling areas. Timber placed at ground level can be selected according to its viscoelasticity*.

STRESSES
The timber is subject to multiple constraints, both climatic and mechanical. In the case of sheds that are more or less protected, the structural timber is subject to climatic vagaries. The floors are subject to the stresses of moving and static loads as well as horizontal forces linked to the movements of machines.

REQUIRED PROPERTIES
Timber that is highly resistant to biological degradation agents that has a high degree of hardness, and that benefits from abundant mechanical properties. Handling shocks and moving and static loads must not weaken the structure.

PRINCIPLES OF IMPLEMENTATION
A robust construction based on simple and powerful assembly systems. The wear parts of the floors (incl. wooden floors) must be interchangeable.

USAGE CLASS
Usage class 4 is required.

SPECIES

Acajou Cailcédrat	Dabéma	Mukulungu
Alep	Diania	Mutenyé
Angueuk	Difou	Niové
Awoura	Doussié	Okan
Azobé	Essia	Osanga
Bilinga	Eveuss	Ozouga
Bodioa	Eyoum	Pachy
Bubinga	Limbali	Padouk d'Afrique
Congotali	Lotofa	Tali
Coula	Moabi	Wamba
	Monghinza	


Photo 69: Heavy duty framework © M. Vernay


Photo 70: Industrial flooring © Fotos593

5.6. VEHICLE, WAGON AND CONTAINER BOTTOM (OR FLOOR)

DEFINITION AND ROLE

Timber is one of the most widely used materials for the manufacture of floors designed to support heavy loads for handling and transport (wagons, truck beds, container bottoms, etc.). Thanks to its easy installation, timber enables an easy and quick replacement of floors in the event of damage. Its high resistance/density ratio and its ability to absorb shocks distinguish it from many other competing materials in this sector.

STRESSES

The floor must be able to withstand heavy loads and withstand shocks without major deformations. Rolling stock used for handling also causes horizontal stresses that accentuate shearing in terms of floor fastenings.

REQUIRED PROPERTIES

The timber must have excellent mechanical properties, especially in flexion, and have a high level of hardness in order to withstand handling shocks and sharp falls from heavy loads. The timber must also be highly resistant to splitting and bursting under heavy loads.

Its durability must allow for use in all climatic conditions: marine environments during maritime transport, repeated or permanent moisture, presence of chemical products, alternating temperatures and thermal shocks.

PRINCIPLES OF IMPLEMENTATION

The timber present in vehicle bottoms and other means of transport is installed in the form of boards, featuring an assembly profile or not, in a thickness that matches the stresses that are encountered. The timber is shaped with facing that is free from defects. The board edges must not present any risk of chipping and are thus generally chamfered. The assembly of the cladding (floor) is done by attaching it to a supporting structure referred to as the “base”, using screws or bolts depending on the situation.

USAGE CLASS

Depending on the nature of the means of transport, the timber used covers usage class 3 or 4.

SPECIES

Alep	Essia	Movingui
Angueuk	Eveuss	Mukulungu
Awoura	Eyoum	Niové
Azobé	Gombé	Okan
Bilinga	Iroko	Osanga
Bodioa	Izombé	Ozouga
Congotali	Kanda	Padouk d'Afrique
Dabéma	Kotibé	Tali
Diania	Landa	
Difou	Limbali	
Douka	Makoré	

Photo 71: Trailer bottom © V. Legris, SBLF

6. SHIPBUILDING

6.1. BOAT DECKS AND PLANKING

DEFINITION AND ROLE
Planking is the set of parts that make up the hull of a boat, fixed externally on the frame's ribs. The waterproofing of the hull is ensured by caulking. Planking can be divided into four zones: the bridge, the walls, the bottoms and the bilges.
The deck of a ship is a platform that is stiffened by structural elements and that is constructed both to prevent the flooding of water into the ship and to support the loads that are to be transported.

STRESSES
Planking must withstand the forces generated by the sea and internal tensions within the boat related to the presence of rigging, as well as shocks caused when the boat is docked. The deck must be waterproof, withstand loads and allow people to move around.

REQUIRED PROPERTIES
To ensure proper waterproofing, the timber must have a low transversal* shrinkage coefficient. It must also demonstrate low density and elastic modulus, as well as high flexural strength (higher density can be used for bottoms and bilges). The selected species must have straight thread (no counter-threading) and a high level of durability, especially with respect to fungi and marine borers. For boat decks, the timber must be aesthetic, have a fairly fine grain with a medium level of hardness and it must not crack*. Slightly oily timber species are sought in order to minimise the risk of slipperiness. Favourable bonding properties are required for assemblies with "boat deck" joints.

PRINCIPLES OF IMPLEMENTATION
Quarter* cuts are preferred for this usage. In certain cases, steam curing* timber makes it easier to use boards for unbending operations.

USAGE CLASS
Permanently immersed timber falls under usage class 5. Timber that is above the waterline falls under usage class 4.

SPECIES

Acajou Cailcédrat	Difou	Makoré
Acajou d'Afrique	Douka	Niangon
Afrormosia	Doussié	Niové
Bété	Iroko	Pachy
Bilinga	Izombé	Padouk d'Afrique
Bossé clair	Kanda	Sapelli
Bossé foncé	Landa	Tiama
	Limbali	Tola

Photo 72: Planking on the Kap Kaval
© Y. Le Berre, PAOTRED AR VRO DE PENMARC'H

Photo 73: Yacht deck © PETTAVINO

6.2. BOAT AND YACHT LAYOUTS

DEFINITION AND ROLE
Timber used for layouts is mainly used for the facing of interior joinery elements, in the form of decorative veneers, plywood panels and sandwich panels. The facings are mounted onto timber frame elements.

STRESSES
Interior layouts are not subject to physical and mechanical stress (nor are they exposed to moisture). Only insecticide treatment can be considered for the most sensitive timber species if there is a proven risk during certain exposures.

REQUIRED PROPERTIES
The timber sought for this purpose is light and stable timber that is suitable for shaping and finishing. The fineness of the grain and the colour of the timber are criteria that vary depending on aesthetic styles and trends in terms of interior cabin design.

PRINCIPLES OF IMPLEMENTATION
Gluing is the most frequently used assembly method. For framing lumber, assembly techniques for interior joinery are preferred.

USAGE CLASS
Usage classes 1 and 2 represent the majority of service situations. It is recommended that the timber be treated against xylophagous larvae before implementation.

SPECIES

Acajou Cailcédrat	Bossé foncé	Okoumé
Acajou d'Afrique	Doussié	Pachy
Bossé clair	Izombé	Sapelli
	Kosipo	Sipo

Photo 74: Interior layout of a yacht © AGUTI YACHTS

6.3. PLEASURE-BOATING PONTOONS

DEFINITION AND ROLE
Floating or non-floating platform serving as a dock or access point.

STRESSES
Pontoons are structures located above the water and subject to the intensive passage of boaters. They must withstand the stresses related to the access and maintenance activities of boats. The deck must maintain a perfect surface condition in order to ensure the comfort and safety of its users.

REQUIRED PROPERTIES
The timber used must be mechanically solid and durable. It must withstand a permanently moist environment.

PRINCIPLES OF IMPLEMENTATION
The implementation is often carried out on structures made with a different material such as aluminium, and the fastening of the planks is ensured by rivets. This construction system makes it easy to dismantle each element. The construction principles are described in the pleasure-pontoon design guide published by the Secretariat of State for the Sea.

Photo 75: Pleasure-boating pontoon © WIJMA

USAGE CLASS
Usage class 4 is required.

SPECIES

Afrormosia	Moabi	Ozouga
Bété	Makoré	Padouk d'Afrique
Bilinga	Mukulungu	Tali
Difou	Niové	
Doussié	Okan	
Izombé	Osanga	

Photo 76: Permanent pontoon © M. Vernay

7. MISCELLANEOUS USES

7.1. COOPERAGE AND VAT MAKING

Photo 77: Small tub © Bhakpong

DEFINITION AND ROLE

Barrels and vats are timber containers made with circularly assembled wooden staves that are held together with hoops.

A barrel has two flat bottoms while a vat is open on its upper part.

Timber intended for the manufacture of vats and barrels is cut into shooks, the cut must be done in quarters*.

Barrels are mainly intended for the ageing and the preservation of liquids such as wines and alcohols. As for timber vats, they are mainly used by industry for the storage of chemicals and for recreational equipment and bathrooms.

STRESSES

Barrels and vats must withstand the pressure of the liquids they contain. Waterproofing and sturdiness must be ensured in all circumstances.

REQUIRED PROPERTIES

Timber used in cooperage is sought on the basis of the following main criteria:

- the content and quality of the tannins contained in the timber and the ability to restore them to the contained liquid;
- acid resistance in the case of industrial vats;
- a relatively neutral pH.

PRINCIPLES OF IMPLEMENTATION

Barrels and vats are still handcrafted. The shooks are cut and shaped according to the desired profile. They are curved while hot in the form of wooden staves and then assembled and hooped.

USAGE CLASS

Depending on the moisture level of the storage place, the timber used falls under usage classes 3 or 4.

SPECIES

Azobé	Doussié	Mukulungu
Bomanga	Iroko	Pachy
Coula	Movingui	Pao rosa

Photo 78: Barrels © Who is Danny

7.2. TURNERY, CUTLERY AND BRUSHMAKING

DEFINITION AND ROLE

Upscale objects fall within the scope of marquetry, decorative work or utility accessories.

For their manufacture, timber species are selected for their aesthetic appearance and for their ability to be machined and shaped in small dimensions.

STRESSES

The only stresses are those involving the timber's ability to maintain its appearance when it comes into contact with water and maintenance products during its use.

REQUIRED PROPERTIES

The timber must be easy to shape and have a thread and grain that is pleasant to the touch. Very high fibre cohesion and a very low likelihood of splitting are essential properties. For certain uses such as cutlery and cooking utensils, the timber's durability and behaviour when in contact with washing agents should be verified. In case of cutlery and brushwork, the timber must have a good capacity to receive a finish and surface protection.

PRINCIPLES OF IMPLEMENTATION

Precision machining, sanding and finishing are the essential points of a good manufacturing technique.

USAGE CLASS

All usage classes are involved in these uses, depending on the timber's degree of exposure to risks of degradation.

SPECIES

Abura	Ebiara	Mambodé
Acajou Cailcédrat	Ekaba	Moabi
Afrormosia	Ekoune	Movingui
Akossika	Framire	Mutenyé
Angueuk	Iatandza	Naga
Bété	Igaganga	Niové
Bodioa	Iroko	Okan
Bubinga	Izombé	Ossoko
Cordia d'Afrique	Kanda	Ovéngkol
Diania	Kondroti	Padouk d'Afrique
Dibétou	Kotibé	Pao rosa
Douka	Koto	Wengé
Ebène d'Afrique	Limba	Zingana
	Longhi	
	Makoré	

Photo 80: Turning © Shutterstock - FreeProd33

Photo 79: Solitaire game © M. Vernay

Photo 81: Knife handles © S. Berthomme, FAROL

7.3. TOOL HANDLES

DEFINITION AND ROLE

This is the part of a tool or instrument held by someone's hand in the context of its use. Characterised by a round or ovoid shape, the handle can have various lengths. It must be able to withstand shocks. It must also be able to absorb them so as not to transmit vibrations to the person using it (in the case of a hammer or a garden tool).

STRESSES

The most stressed handles are those of striking tools, as they must absorb shocks and resist bending.

REQUIRED PROPERTIES

The timber species sought for this purpose must have good mechanical properties, and especially good resistance against shocks and bending. The wood must be highly resilient* and easy to shape. The surface condition must remain smooth and free from sharp edges and scratches during use. The main risks are breaking and splitting of the timber.

PRINCIPLES OF IMPLEMENTATION

In general, these are pieces obtained by turning or by special shaping. Not all handles are suitable to receive a finish.

USAGE CLASS

This notion is not essential in the choice of a species for the manufacture of tool handles. As such, the usage class varies from 1 to 3.

SPECIES

Ebène d'Afrique
Kotibé
Pao rosa
Zingana

Photo 82: Tool handles © M. Vernay

7.4. MUSICAL INSTRUMENTS

Photo 83: Piano keys © Sunny baby

Photo 84: Clarinet © Africa Studio

DEFINITION AND ROLE

In a musical instrument, the timber contributes to the acoustic quality and the sound, especially for guitars and pianos. In a guitar, it is a part of many elements in the form of solid timber or veneering. For the manufacture of the body, the bottom and the sides, lighter timber species are generally used, while heavier, denser and aesthetic timber species are sought for the manufacture of handles, heads, easels and keys.

STRESSES

The timber must provide the instrument with a certain sound quality. It is sought for its homogeneity and for its ability to reproduce a sound in a balanced manner within a broad spectrum of frequencies. In terms of guitars, hard timber species must be able to resist friction and the effects of sweating.

REQUIRED PROPERTIES

The aesthetic aspect is essential. The timber's density and grain are also important criteria in the choice. The timber must also have a good drying ability and demonstrate high stability during its use.

The CIRAD's* technical sheets provide two characteristics to facilitate the choice of a species for a musical instrument:

- the resonance frequency, which is the main frequency of the material's audible sound
- the musical quality factor, Q, which is associated with the duration of the audible sound. The higher the quality factor, the more the sound is sustained over time (low damping).

PRINCIPLES OF IMPLEMENTATION

The timber that is used is obtained by fine sawing or by slicing. Implementation is carried out using techniques specific to these instruments. Implementation must be carried out in perfectly controlled climatic environments. The shaping and adjustment of each element requires a high degree of precision.

USAGE CLASS

Durability is not a selection criterion characterizing mark for this usage.

SPECIES

Avodiré
Bubinga
Ebène d'Afrique
Ovéngkol
Pao rosa

Photo 85: Guitar body and bracing © Luciano Queiroz

7.5. SCULPTURES

DEFINITION AND ROLE

The art of sculpture consists of removing material from a piece of timber to produce a work called a “sculpture”. We can distinguish between different types of sculptures: essentially low relief, high relief and ronde-bosse, or statuary sculpture.

STRESSES

The timber must be shapable using sharp tools.

REQUIRED PROPERTIES

Timber used for sculptures must be dry, it must not be brittle and it must not release its internal stresses when it is being carved. The absence of interlocking or knotty thread is desirable in terms of chiselling work; in some cases, interlocking thread and rough wood can be sought for their aesthetic appearance.
Timber that is resistant to biological degradation agents is appropriate for exposed outdoor sculptures.
The ability to receive a finish must be taken into account.

PRINCIPLES OF IMPLEMENTATION

All timber species can be sculpted, but starting at a certain level of density, it is preferable to use electric power tools that are more effective than manual tools.

USAGE CLASS

No specific usage classes are required for this use.

SPECIES

Abura	Essessang	Okan
Ayous	Izombé	Ossoko
Difou	Kotibé	Padouk d'Afrique
Douka	Longhi	Pao rosa
Ebène d'Afrique	Makoré	Wengé
	Moabi	

Photo 86: Sculpture © Shutterstock - Petar Tasevski

Photo 87: Sculpture © Shutterstock - Art65395

7.6. PACKING AND CRATING

DEFINITION AND ROLE

There are two types of products: crates for the transport of goods and industrial products and packaging for the packing and transport of perishable foodstuffs.

STRESSES

The stresses vary depending on the expected loads and the products that are to be transported.
Heavy and significant loads are packed in timber frame crates that are sized accordingly. Average quality plywood is often used for the walls. For the packaging and packaging of food products, light-coloured timber with straight thread suitable for use in low thicknesses is preferred.

REQUIRED PROPERTIES

The timber used for crates is light timber, with a straight or slightly curved thread, and with a fine to medium grain. Uncoloured timber species are preferred in order to avoid tannin run-off problems.

Photo 88: Crates © M. Vernay

Photo 89: Wood punnet for food © divgradcurl

Photo 90: Pallet © M. Vernay

PRINCIPLES OF IMPLEMENTATION

There is a distinction between peeled timber used for the manufacture of panels and packaging, and sawn timber intended for the frames of crates. The ISPM 15 (International Standard for Phytosanitary Measures) measure requires an appropriate treatment of packaging for international trade.

USAGE CLASS

Given the expected lifespan, usage classes 1 and 2 can be used.

SPECIES

Abura	Essessang	Limba
Aiélé	Faro	Okoumé
Ako	Fuma	Olon
Andoung	Gombé	Onzabili
Ayous	Iatandza	Ossoko
Bomanga	Igaganga	Ozigo
Diania	Ilomba	Safukala
Ekaba	Kondroti	Tchitola
Ekoune	Koto	Tola
Emien	Lati	

	1. STRUCTURES AND PANELS	1.1. LIGHTWEIGHT STRUCTURES	1.2. GLUED LAMINATED TIMBER	1.3. FINGER JOINTS	1.4. PLYWOOD, INSIDE FACE AND OUTSIDE FACE	1.5. PLYWOOD, INNER LAYERS	1.6. SLICED VENEERS	2. EXTERIOR JOINERY (BUILDING FAÇADE)	2.1. CLADDING AND OUTER COATING	2.2. WINDOWS AND DOORS	2.3. SCREEN WALLS AND SOLAR SHADING	2.4. SHUTTERS AND CLOSURES	3. CARPENTRY AND INTERIOR FITTINGS	3.1. WOODEN FLOORS	3.2. INTERIOR STAIRCASES	3.3. DOORS AND DOOR FRAMES	3.4. MOULDING	3.5. INTERIOR PANELLING AND CLADDING	3.6. LAYOUT AND FURNISHINGS	3.7. FURNITURE AND CABINETMAKING	4. OUTDOOR EQUIPMENT - RECREATION	4.1. EXTERIOR STAIRCASES AND GUARD RAILINGS	4.2. SINGLE-LEVEL TERRACES AND POOL AREAS
ABURA					✔	✔	✔									✔	✔	✔	✔	✔			
ACAJOU CAILCÉDRAT							✔							✔	✔	✔		✔	✔	✔			
ACAJOU D'AFRIQUE		✔			✔		✔		✔	✔		✔				✔		✔	✔	✔			
AFRORMOSIA							✔		✔	✔		✔		✔	✔	✔		✔	✔	✔		✔	✔
AIELÉ					✔	✔	✔									✔		✔	✔				
AKO					✔	✔	✔									✔	✔	✔	✔				
AKOSSIKA		✔	✔		✔		✔							✔	✔	✔	✔	✔	✔	✔			
ALEP																						✔	✔
ANDOUNG		✔			✔	✔	✔			✔		✔		✔	✔	✔		✔	✔				
ANGUEUK							✔			✔						✔							✔
ANIÉGRÉ		✔	✔		✔	✔	✔									✔	✔		✔	✔			
AVODIRÉ							✔									✔	✔	✔	✔	✔			
AWOURA							✔							✔	✔	✔		✔	✔	✔			
AYOUS					✔	✔	✔									✔	✔	✔	✔				
AZOBÉ																						✔	✔
BÉTÉ		✔	✔		✔		✔			✔	✔	✔		✔		✔	✔	✔		✔			✔
BILINGA							✔		✔					✔		✔			✔	✔		✔	✔
BODIOA							✔			✔						✔		✔					
BOMANGA		✔	✔		✔	✔	✔							✔	✔	✔		✔	✔	✔			
BOSSÉ CLAIR		✔		✔	✔	✔	✔		✔	✔	✔	✔		✔		✔		✔	✔	✔			✔
BOSSÉ FONCÉ		✔		✔	✔	✔	✔		✔	✔	✔	✔		✔		✔		✔	✔	✔			✔
BUBINGA							✔			✔				✔	✔	✔		✔	✔				
CONGOTALI																						✔	✔
CORDIA D'AFRIQUE							✔			✔		✔				✔		✔	✔	✔			
COULA																							
DABÉMA			✔		✔	✔			✔										✔				
DIANIA					✔	✔	✔							✔	✔	✔	✔	✔	✔				
DIBÉTOU		✔			✔		✔									✔		✔	✔	✔			
DIFOU							✔		✔	✔	✔			✔	✔	✔		✔	✔	✔		✔	✔
DOUKA		✔			✔	✔	✔		✔	✔	✔	✔		✔	✔	✔		✔	✔	✔		✔	✔
DOUSSIÉ							✔		✔	✔	✔			✔	✔	✔		✔	✔	✔		✔	✔
EBÈNE D'AFRIQUE																				✔			
EBIARA		✔			✔		✔		✔	✔		✔		✔	✔	✔		✔	✔	✔			
EKABA		✔	✔		✔	✔			✔	✔		✔				✔	✔	✔	✔				
EKOUNE		✔			✔	✔	✔		✔	✔		✔				✔	✔	✔	✔				
EMIEN						✔										✔	✔		✔				
ESSESSANG						✔											✔		✔				
ESSIA							✔																
ETIMOÉ		✔	✔		✔	✔	✔		✔	✔		✔		✔	✔	✔	✔	✔	✔	✔			
EVEUSS																						✔	✔
EYONG					✔		✔							✔		✔		✔	✔				
EYOUM							✔		✔	✔				✔								✔	✔
FARO						✔	✔									✔			✔				
FRAMIRE		✔	✔		✔	✔	✔		✔	✔		✔		✔	✔	✔	✔	✔	✔				
FUMA						✔											✔		✔				
GOMBÉ		✔			✔	✔	✔			✔		✔				✔	✔	✔	✔				
IATANZA		✔	✔		✔	✔	✔		✔	✔		✔		✔	✔	✔		✔	✔	✔			✔
IGAGANGA				✔	✔	✔	✔							✔	✔	✔	✔		✔				
ILOMBA					✔	✔			✔							✔	✔	✔	✔				

POSSIBLE USES OF SPECIES: DESCRIPTION AND REQUIREMENTS

	4.3. ELEVATED TERRACES, BALCONIES AND CORRIDORS	4.4. SHELTERS, OUTDOOR FURNITURE AND PLAYGROUNDS	4.5. GATES	4.6. VISUAL BARRIERS AND WINDBREAK PANELS, PERGOLAS	5. INDUSTRIAL USAGE AND HEAVY WORK	5.1. HYDRAULIC WORKS IN A SUBMERGED MARINE ENVIRONMENT	5.2 STRUCTURES AND BRIDGES IN CONTACT WITH SOIL OR FRESH WATER	5.3. ACOUSTIC BARRIERS IN URBAN AREAS ALONG RAILROADS AND HIGHWAYS	5.4. SLEEPERS AND DUNNAGE TIMBER	5.5. INDUSTRIAL FLOORS AND HEAVY FRAMEWORK	5.6. VEHICLE, WAGON AND CONTAINER BOTTOM (OR FLOOR)	6. SHIPBUILDING	6.1. BOAT DECKS AND PLANKING	6.2. BOAT AND YACHT LAYOUTS	6.3. PLEASURE-BOATING PONTOONS	7. MISCELLANEOUS USES	7.1. COOPERAGE AND VAT MAKING	7.2. TURNERY, CUTLERY AND BRUSHMAKING	7.3. TOOL HANDLES	7.4. MUSICAL INSTRUMENTS	7.5. SCULPTURES	7.6. PACKING AND CRATING
ABURA																		✔			✔	✔
ACAJOU CAILCÉDRAT										✔			✔	✔				✔				
ACAJOU D'AFRIQUE													✔	✔								
AFRORMOSIA	✔	✔	✔	✔									✔		✔			✔				
AIELÉ																						✔
AKO																						✔
AKOSSIKA																		✔				
ALEP	✔						✔	✔	✔	✔	✔											
ANDOUNG																						✔
ANGUEUK		✔	✔	✔						✔	✔							✔				
ANIÉGRÉ																						
AVODIRÉ																				✔		
AWOURA										✔	✔											
AYOUS																					✔	✔
AZOBÉ	✔					✔	✔	✔	✔	✔	✔						✔					
BÉTÉ	✔						✔	✔					✔		✔			✔				
BILINGA	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔		✔		✔							
BODIOA										✔	✔							✔				
BOMANGA																	✔					✔
BOSSÉ CLAIR		✔	✔	✔									✔	✔								
BOSSÉ FONCÉ		✔	✔	✔									✔	✔								
BUBINGA										✔								✔		✔		
CONGOTALI	✔					✔	✔	✔	✔	✔	✔											
CORDIA D'AFRIQUE																		✔				
COULA							✔	✔	✔	✔							✔					
DABÉMA										✔	✔											
DIANIA										✔	✔							✔				✔
DIBÉTOU																		✔				
DIFOU	✔	✔	✔	✔			✔	✔	✔	✔	✔		✔		✔						✔	
DOUKA	✔	✔	✔	✔			✔				✔		✔					✔			✔	
DOUSSIÉ	✔	✔	✔	✔			✔	✔		✔			✔	✔	✔		✔					
EBÈNE D'AFRIQUE																		✔	✔	✔	✔	
EBIARA																		✔				
EKABA																		✔				✔
EKOUNE																		✔				✔
EMIEN																						✔
ESSESSANG																					✔	✔
ESSIA										✔	✔											
ETIMOÉ																						
EVEUSS	✔						✔	✔	✔	✔	✔											
EYONG																						
EYOUM	✔						✔	✔	✔	✔	✔											
FARO																						✔
FRAMIRE																		✔				
FUMA																						✔
GOMBÉ											✔											✔
IATANZA		✔	✔	✔														✔				✔
IGAGANGA																		✔				✔
ILOMBA																						✔

POSSIBLE USES OF SPECIES: DESCRIPTION AND REQUIREMENTS

	1. STRUCTURES AND PANELS	1.1. LIGHTWEIGHT STRUCTURES	1.2. GLUED LAMINATED TIMBER	1.3. FINGER JOINTS	1.4. PLYWOOD, INSIDE FACE AND OUTSIDE FACE	1.5. PLYWOOD, INNER LAYERS	1.6. SLICED VENEERS	2. EXTERIOR JOINERY (BUILDING FAÇADE)	2.1. CLADDING AND OUTER COATING	2.2. WINDOWS AND DOORS	2.3. SCREEN WALLS AND SOLAR SHADING	2.4. SHUTTERS AND CLOSURES	3. CARPENTRY AND INTERIOR FITTINGS	3.1. WOODEN FLOORS	3.2. INTERIOR STAIRCASES	3.3. DOORS AND DOOR FRAMES	3.4. MOULDING	3.5. INTERIOR PANELLING AND CLADDING	3.6. LAYOUT AND FURNISHINGS	3.7. FURNITURE AND CABINETMAKING	4. OUTDOOR EQUIPMENT - RECREATION	4.1. EXTERIOR STAIRCASES AND GUARD RAILINGS	4.2. SINGLE-LEVEL TERRACES AND POOL AREAS
IROKO		✔	✔		✔	✔	✔			✔	✔	✔		✔	✔	✔		✔	✔	✔			✔
IZOMBÉ							✔			✔	✔	✔		✔	✔	✔	✔	✔	✔	✔			✔
KANDA		✔	✔		✔	✔	✔		✔	✔	✔	✔		✔	✔	✔		✔	✔	✔		✔	✔
KONDROTI					✔	✔										✔	✔	✔	✔				
KOSIPO		✔	✔	✔	✔		✔		✔	✔		✔		✔	✔	✔		✔	✔	✔			
KOTIBÉ					✔	✔	✔			✔				✔	✔	✔		✔	✔	✔			
KOTO		✔			✔		✔									✔	✔	✔	✔				
LANDA					✔	✔	✔		✔	✔		✔		✔	✔	✔		✔	✔			✔	✔
LATI							✔							✔		✔	✔	✔	✔				
LIMBA		✔	✔		✔	✔	✔								✔	✔	✔	✔	✔				
LIMBALI									✔	✔	✔				✔	✔		✔					✔
LONGHI		✔	✔		✔		✔							✔	✔	✔		✔	✔	✔			
LOTOFA					✔	✔	✔				✔			✔	✔	✔		✔	✔				
MAKORÉ		✔			✔	✔	✔		✔	✔	✔	✔		✔	✔	✔		✔	✔	✔		✔	✔
MAMBODÉ							✔			✔				✔	✔	✔		✔	✔	✔			
MOABI					✔	✔	✔			✔	✔			✔	✔	✔		✔	✔	✔		✔	✔
MONGHINZA																							✔
MOVINGUI		✔	✔		✔		✔		✔	✔		✔		✔	✔	✔		✔	✔	✔			
MUKULUNGU							✔		✔					✔								✔	✔
MUTENYÉ							✔							✔	✔	✔		✔	✔	✔			
NAGA		✔	✔		✔		✔							✔	✔	✔		✔	✔	✔			
NIANGON		✔			✔		✔		✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔			
NIOVÉ							✔		✔	✔				✔	✔	✔		✔	✔	✔		✔	✔
OBOTO																							
OKAN														✔								✔	✔
OKOUMÉ				✔	✔	✔	✔									✔	✔	✔	✔				
OLON		✔	✔		✔	✔	✔									✔	✔	✔	✔				
OLONVOGO							✔									✔	✔	✔	✔				
ONZABILI		✔			✔	✔	✔									✔	✔		✔				
OSANGA									✔	✔	✔			✔	✔	✔						✔	✔
OSSOKO														✔		✔	✔	✔	✔				
OVÉNGKOL							✔		✔	✔				✔	✔	✔		✔	✔	✔		✔	✔
OZIGO					✔	✔								✔	✔	✔		✔	✔				
OZOUGA														✔								✔	
PACHY							✔		✔	✔	✔			✔	✔	✔		✔	✔			✔	✔
PADOUK							✔				✔			✔	✔	✔				✔		✔	✔
PAO ROSA							✔													✔			
SAFUKALA		✔			✔	✔								✔		✔		✔	✔				
SAPELLI		✔		✔	✔	✔	✔			✔		✔		✔	✔	✔		✔	✔	✔			
SIPO		✔	✔	✔	✔		✔			✔		✔			✔	✔	✔	✔	✔	✔			
SOUGUÉ																							
TALI																						✔	✔
TCHITOLA		✔	✔		✔	✔	✔		✔	✔		✔				✔			✔				
TIAMA		✔		✔	✔		✔		✔	✔		✔		✔	✔	✔		✔	✔	✔			
TOLA		✔	✔		✔	✔	✔		✔	✔	✔	✔				✔	✔	✔	✔				
WAMBA																							
WENGÉ							✔		✔	✔				✔		✔		✔	✔	✔			
ZINGANA							✔											✔	✔	✔			

POSSIBLE USES OF SPECIES: DESCRIPTION AND REQUIREMENTS

	4.3. ELEVATED TERRACES, BALCONIES AND CORRIDORS	4.4. SHELTERS, OUTDOOR FURNITURE AND PLAYGROUNDS	4.5. GATES	4.6. VISUAL BARRIERS AND WINDBREAK PANELS, PERGOLAS	5 UTILISATION INDUSTRIELLE ET TRAVAUX LOURDS	5.1. HYDRAULIC WORKS IN A SUBMERGED MARINE ENVIRONMENT	5.2. STRUCTURES AND BRIDGES IN CONTACT WITH SOIL OR FRESH WATER	5.3. ACOUSTIC BARRIERS IN URBAN AREAS ALONG RAILROADS AND HIGHWAYS	5.4. SLEEPERS AND DUNNAGE TIMBER	5.5. INDUSTRIAL FLOORS AND HEAVY FRAMEWORK	5.6. VEHICLE, WAGON AND CONTAINER BOTTOM (OR FLOOR)	6. SHIPBUILDING	6.1. BOAT DECKS AND PLANKING	6.2. BOAT AND YACHT LAYOUTS	6.3. PLEASURE-BOATING PONTOONS	7. MISCELLANEOUS USES	7.1. COOPERAGE AND VAT MAKING	7.2. TURNERY, CUTLERY AND BRUSHMAKING	7.3. TOOL HANDLES	7.4. MUSICAL INSTRUMENTS	7.5. SCULPTURES	7.6. PACKING AND CRATING
IROKO											✔		✔				✔	✔				
IZOMBÉ		✔	✔	✔							✔		✔	✔	✔			✔			✔	
KANDA	✔	✔	✔	✔							✔		✔					✔				
KONDROTI																		✔				✔
KOSIPO														✔								
KOTIBÉ											✔							✔	✔		✔	
KOTO																		✔				✔
LANDA	✔										✔		✔									
LATI																						✔
LIMBA																		✔				✔
LIMBALI										✔	✔		✔									
LONGHI																		✔			✔	
LOTOFA										✔												
MAKORÉ	✔	✔	✔	✔			✔				✔		✔		✔			✔			✔	
MAMBODÉ																		✔				
MOABI	✔					✔	✔		✔	✔					✔			✔			✔	
MONGHINZA	✔					✔	✔	✔	✔	✔												
MOVINGUI											✔						✔	✔				
MUKULUNGU	✔					✔	✔		✔	✔	✔				✔		✔					
MUTENYÉ										✔								✔				
NAGA																		✔				
NIANGON													✔									
NIOVÉ	✔	✔	✔	✔			✔		✔	✔	✔		✔		✔			✔				
OBOTO			✔	✔																		
OKAN	✔	✔	✔	✔		✔	✔		✔	✔	✔				✔			✔			✔	
OKOUMÉ														✔								✔
OLON																						✔
OLONVOGO																						
ONZABILI																						✔
OSANGA									✔	✔	✔				✔							
OSSOKO																		✔			✔	✔
OVÉNGKOL																		✔		✔		
OZIGO																						✔
OZOUGA	✔						✔		✔	✔	✔				✔							
PACHY	✔	✔	✔	✔			✔	✔		✔			✔	✔			✔					
PADOUK	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔		✔		✔			✔			✔	
PAO ROSA																	✔	✔	✔	✔	✔	
SAFUKALA																						✔
SAPELLI													✔	✔								
SIPO														✔								
SOUGUÉ						✔																
TALI	✔	✔	✔	✔			✔		✔	✔	✔				✔							
TCHITOLA																						✔
TIAMA													✔									
TOLA													✔									✔
WAMBA	✔					✔	✔			✔												
WENGÉ																		✔			✔	
ZINGANA																		✔	✔			

GLOSSARY

Absorption: the action of absorbing, drawing a fluid

Adsorption: the phenomenon whereby a body retains a liquid

AFD: *Agence Française de Développement* - French Development Agency

Anhydrous: does not contain water

ATIBT: *Association Technique Internationale des Bois Tropicaux* - International Technical Association of Tropical Timber

Autoclave: an enclosure in which vacuum and pressure cycles (Bethell process) ensures that a product diluted within a liquid penetrates timber to a greater depth than would otherwise be achieved via soaking

Biocide: a chemical that destroys life

CIRAD: *Centre International de Recherche Agronomique pour le Développement* - International Centre of Agricultural Research for Development

Conformation: the external appearance of a tree that consists of: its straightness, the regularity of the section across its height, defects, injuries, the base, etc.

Crack: a superficial slit that can appear on the timber's surface when it is drying

Creep: a deferred irreversible deformation of a material that bears a constant load

CSR: corporate social responsibility - a concept in which companies integrate social, environmental, and economic concerns in their activities and in their interactions with stakeholders on a voluntary basis

CTFT: *Centre Technique Forestier Tropical* - Technical Centre for Tropical Forestry

Cubical rot: timber degradation caused by fungi that destroy cellulose without altering the lignin. Timber with cubical rot is brown coloured, cleaves according to the three orthogonal planes and forms small cubes that are more or less regular. Also known as brown rot.

Desorption: the phenomenon contrary to adsorption*

Durability: timber's resistance property against physical and biological aggressions

Duraminization: the physico-chemical transformation of sapwood* into duramen*

Eco-certified: which meets the requirements of a sustainable development (ecological, social and economic) label, which are controlled by an external body

EN: European Norm

ENGREF: *Ecole Nationale du Génie Rural des Eaux et Forêts* - National School of Agricultural Engineering of Water and Forests

ENSTIB: *Ecole Nationale Supérieure des Technologies et Industries du Bois* - National School of Timber Technologies and Industries

Eurocode: European standard overseeing the design, dimensions and justifications pertaining to building and civil engineering structures

EUTR: EU Timber Regulation. Regulation that aims to exclude from the EU market all timber and timber products that are derived from illegal harvesting. Also known as *RBUE: Règlement Bois de l'Union Européenne*

Exothermic: a reaction that releases heat

Figure: remarkable decorative appearance

Fireproofing: a treatment that allows one to improve the fire resistance of a material

FLEGT: Forest Law for Enforcement, Governance and Trade. Licence system that attests to the legality of the product imported into Europe in accordance with VPA* requirements

Forest management unit: a homogeneous or biogeographically consistent plot of land enabling rational management planning.

FSC: Forest Stewardship Council. A label that certifies the responsible management of forests.

FSP: Fibre saturation point

Harmonised standard: a shared standard that is applicable in all States of the European Community

Heartwood: the inner zone of timber which, in a standing tree, no longer contains living cells and no longer leads the sap. In this zone of the timber, the tree stored molecules during its growth, conferring a certain level of durability. Also referred to as perfect wood

Hydrophilic: has an affinity for water

Hydrophobic: which cannot be wet

Hygroscopic: the capacity of a material to lose and to regain moisture as a function of temperature, and above all, moisture in relation to ambient air

Imago: an insect in its adult state

Impregnability: the ability of a body to absorb liquid

Indentation: the deformation of a surface under the weight of a load concentrated on a localised zone

Internal sapwood: the non-duraminized* timber zone that is surrounded by duraminized* timber

Isotropic: the qualification of a material whose properties are identical in all directions

ITTO: International Tropical Timber Organization

Larva: the embryonic form, in the worm state, of an insect

Lignicolous: growing or living on or in wood

Lignivorous: feeds on wood while degrading it

Longitudinal: in the direction of the wood fibres (opposite: transversal*)

Managed forest: a forest massif divided into several forest management units* in which the harvest of about one tree per hectare is planned every 30 years by rotation, among other things

Marine borer: a mollusc that digs galleries in wood

Non-biodegradable: does not rot

Nymph: the intermediate form taken by an insect between the larva and the imago* form

Orthotropic: qualification of a material whose properties are different in 3 directions that are perpendicular to each other

PEFC: Pan European Forest Certification Council. A label that certifies the responsible management of forests.

PPECF: *Programme de Promotion de l'Exploitation Certifiée des Forêts* - Program for the Promotion of Certified Forest Operations

Quarter: cutting mode in which the largest dimension of a transversal* section is oriented in the radial direction

Radial: orientation starting at the core of the tree towards the bark, perpendicular to the growth rings

REACH: Registration, Evaluation, Authorisation and restriction of CHemicals

Resilience: the ability of a material to withstand shocks and resume its initial structure

Round timber: Felled, disbranched and dried timber that has been cut into sections (or not), excluding firewood

Sapwood: the outer zone of the timber which, in a standing tree, contains living cells and leads the raw sap

Singularity: the morphological or anatomical characteristic of timber that is likely to affect the use or implementation of the material (knot, crack, reaction wood, resin pocket, crack*, etc.)

Slab: result of cutting mode in which the largest dimension of a transversal* section is oriented in the tangential* direction

Slash-and-burn agriculture: an agrarian system in which fields are cleared by fire, to enable a transfer of fertility, and then are cultivated for a brief period before a fallow, usually a forest, with a long turnover cycle

Soft rot: timber degradation caused by fungi that destroy cellulose. Timber with soft rot softens and becomes spongy.

Squared timber: a heavy duty piece of timber that is rather square, obtained by sanding down a ball of timber

Steam curing: the treatment of timber with steam to soften it before bending, slicing or rotary cutting

Subatmospheric: lower than atmospheric pressure

Tangential: is oriented tangentially to the growth rings

Thermoplastic: refers to a material that softens when heated and becomes hard again after each cooling

Thermosetting: refers to a solid, nonmeltable material that is obtained through irreversible polymerisation

Transfer: chemical interaction at the surface of the substrates that allows glue to bond

Transversal: in a direction perpendicular to the timber's fibres, encompassing the radial and tangential* directions

TROPIX: CIRAD's interactive software describing the properties of 245 tropical species

Viscoelastic: the capacity of a material to retain and restore energy after deformation

VPA: Voluntary Partnership Agreement. A negotiated agreement between the European Commission, States exporting timber to Europe and the private sector, defining the criteria and means of verification that certify the legality of timber

White rot: timber degradation caused by fungi that simultaneously destroy cellulose and lignin. Timber characterised by fibrous rot decomposes into small fibres and assumes a very clear colouring.

Xylophage: a living organism whose diet consists mainly of wood

PHOTO CREDITS

ANNEXES

ANNEX 1: NATURAL DURABILITY OF TIMBER (HEARTWOOD*)

ATIBT PILOT NAME	MV MIN KG/M^3	MV KG/M^3	MV MAX KG/M^3	FUNGUS	HYLO-TRUPES	ANOBIUM	TERMITES	IMPREGNA-BILITY*	SAPWOOD	SAPWOOD WIDTH	MARINE BORERS
ABURA	550	560	600	5	S	S	S	2	1	m	S
ACAJOU D'AFRIQUE	490	520	530	3	D	S	S	4	2	f	S
AFRORMOSIA	680	690	710	1-2	D	D	D	4	1	tf	S-M
AIÉLÉ	490	500	530	5	nd	nd	S	4	1	m	S
AKO	430	450	460	5	S	S	S	1	1	x	S
ALEP	950	1050	1150	1	D	D	D	4	nd	m	D
ANIÉGRÉ	540	580	630	4	S	S	S	1	1	X	S
ANGUEUK	800	900	950	2	D	D	D	3	nd	M	S
AVODIRÉ	540	550	560	4	S	S	S	4	1	X	S
AWOURA	700	750	850	3	D	D	S-M	3	nd	L	S
AYOUS	370	390	400	5	S	S	S	3	1	X	S
AZOBÉ	950	1060	1100	2V	D	D	D	4	2	F	M-D
BÉTÉ	600	610	620	1	D	D	M	4	1	F	S
BILINGA	740	750	780	1	nd	nd	D	2	1	F	M-D
BOSSÉ CLAIR	570	580	630	2V	D	D	S	4	1	M	S
BOSSÉ FONCÉ	600	690	850	2	nd	nd	S	4	1	M	nd
BUBINGA	700	830	910	2	D	D	D	4	1	F	S-M
CORDIA D'AFRIQUE	520	540	550	2	D	D	M	1	3	F	S
COULA	900	1000	1100	1	D	D	D	3	nd	F	S
DABÉMA	600	700	800	3	D	D	D	2	nd	F-L	S
DIBÉTOU	520	550	590	3-4	D	D	S	3-4	2	F	S
DIFOU	750	850	950	1	D	D	D	3	nd	M	S
DOUKA	620	660	720	1	D	D	D	4	2	M	D
DOUSSIÉ	730	800	830	1	D	D	D	4	2	F	S
EVEUSS	1000	1050	1150	1	D	D	D	3	nd	nd	S
EYONG	700	730	800	4	S	S	S	3-4	1	X	S
EYOUM	800	950	1050	1	D	D	D	4	nd	F-M	S
FARO	480	490	510	4-5	nd	nd	S	2-3	1	L	nd
FRAMIRE	520	550	560	2-3	S	S	S	4	2	(X)	S
FUMA	290	320	350	5	S	S	S	1	1	X	S
ILOMBA	440	480	510	5	S	S	S	1	1	X	S
IROKO	630	650	670	1-2J	D	D	D	4	1	M	D
KONDROTI	470	480	490	5	D	D	S	1	1	L	S
KOSIPO	640	670	720	2-3	D	D	M	3	1	F	S
KOTIBÉ	710	730	760	3V	D	D	M-D	3-4	1-2	F	S
KOTO	510	560	630	5	nd	nd	S	1	1	X	nd
LATI	730	750	770	3	nd	nd	S	4	2	M	S
LIMBA	550	560	600	4	S	S	S	2	1	(X)	S
LIMBALI	700	800	900	2	D	D	S-M	3	nd	M	S
LONGHI	700	730	800	4	S	S	S	1	2	X	S
MAKORÉ	620	660	720	1	D	D	D	4	2	M	D
MOABI	770	800	830	1	D	D	D	3-4	nd	M	D
MOVINGUI	690	710	740	3	D	D	M	4	nd	F	S
NIANGON	670	680	710	3	D	D	M-D	4	3	M	S
OKAN	850	920	960	1	D	D	D	4	3	F	D
OKOUMÉ	430	440	450	4	D	D	S	3	nd	F	S
OVENGKOL	720	780	820	2	D	D	D	3	1	M	S
PADOUK	720	740	820	1	D	D	D	2	nd	M	D
SAPELLI	640	650	700	3	D	D	M	3	2	M	S
SIPO	590	640	660	2-3	D	D	M	4	2	M	M
TCHITOLA	590	610	640	3	D	D	M	3-4	1	L	S
TIAMA	550	560	570	3	D	D	S	4	3	L	S
TOLA	480	500	510	2-3	S	S	S	3	1	M	S
WENGÉ	780	830	900	2	D	D	D	4	nd	F	S

Key relating to the preceding tables:

Durability with respect to fungi: 1 = highly durable; 2 = durable; 3 = moderately durable; 4 = slightly durable; 5 = nondurable

Durability with respect to xylophagous* larval insects, Hylotrupes (old-house borer) and Anobium (common furniture beetle): S = sensitive or D = durable

Durability with respect to termites: S = sensitive, M = moderately durable or D = durable

Durability with respect to marine borers*: D = durable; M = moderately durable; S = sensitive

Impregnability*: 1 = impregnable; 2 = moderately impregnable; 3 = slightly impregnable; 4 = non-impregnable

The width of the sapwood: tf < 2 cm; f < 5 cm; m < 10 cm; l > 10 cm; x without distinction

“nd” = performance not determined.

ANNEX 2: STANDARDS SPECIFYING THE MECHANICAL CLASSES OF TROPICAL TIMBER SPECIES

SPECIES	MECHANICAL CLASSES	VISUAL GRADING STANDARDS
ACAJOU CAILCÉDRAT	D24	NF B 52-001
ANDOUNG	D30	NF B 52-001
AWOURA	D40	NF B 52-001
AYOUS	D18	NF B 52-001
AZOBÉ	D70	NEN 5493
AZOBÉ	D70	BS 5756
AZOBÉ	D50	NF B 52-001
BÉTÉ	D35	NF B 52-001
BILINGA	D50	BS 5756
BILINGA	D35	NF B 52-001
BOMANGA	D24	NF B 52-001
BOSSÉ	D30	NF B 52-001
BUBINGA	D40	NF B 52-001
CELTIS AFRICANA	D35	NF B 52-001
DABÉMA	D30	NF B 52-001
DOUSSIÉ	D40	NF B 52-001
EKOUNE	D24	NF B 52-001
FARO	D18	NF B 52-001
IATANDZA	D24	NF B 52-001
ILOMBA	D18	NF B 52-001
IROKO	D40	BS 5756
IROKO	D30	NF B 52-001
KANDA	D35	NF B 52-001
LIMBA	D24	NF B 52-001
LIMBALI	D40	NF B 52-001
LONGHI	D40	NF B 52-001
MAKORÉ	D30	NF B 52-001
MUKULUNGU	D40	NF B 52-001
NIANGON	D35	NF B 52-001
NIOVÉ	D50	NF B 52-001
OKAN	D40	NEN 5493
OKAN	D40	NF B 52-001
OKOUMÉ	D18	NF B 52-001
OVENGKOL	D40	NF B 52-001
PADOUK	D40	NF B 52-001
SAPELLI	D40	BS 5756
SAPELLI	D35	NF B 52-001
TALI	D40	NEN 5493
TALI	D40	NF B 52-001
TIAMA	D18	NF B 52-001

ANNEXES

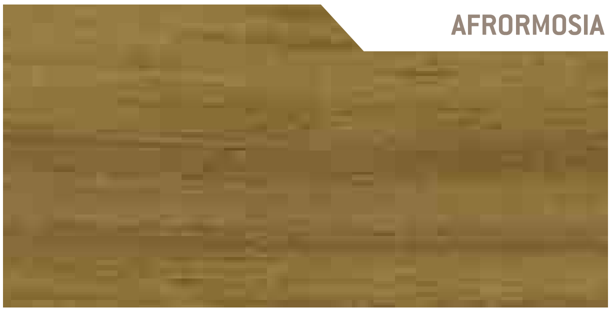
ANNEX 3: AFRICAN SPECIES

ABURA

ACAJOU CAILCÉDRAT

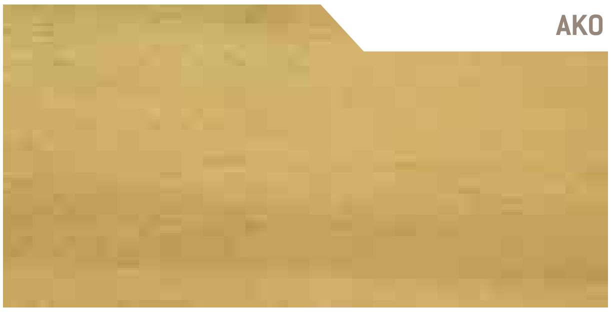
ACAJOU D'AFRIQUE

AFRORMOSIA

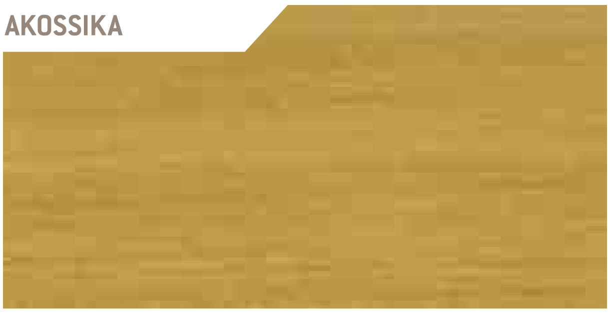


AIELÉ

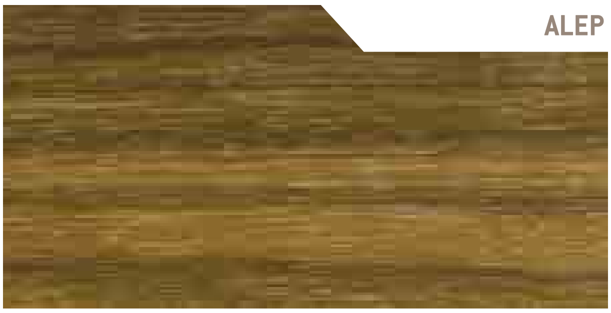
AKO



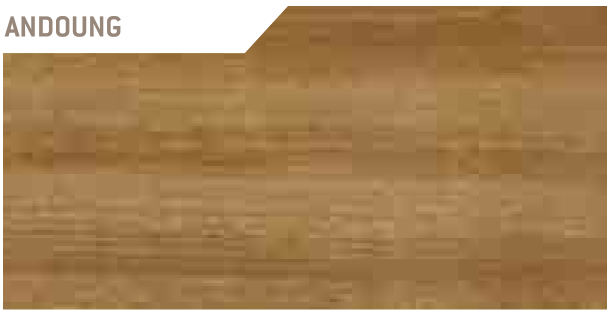
AKOSSIKA



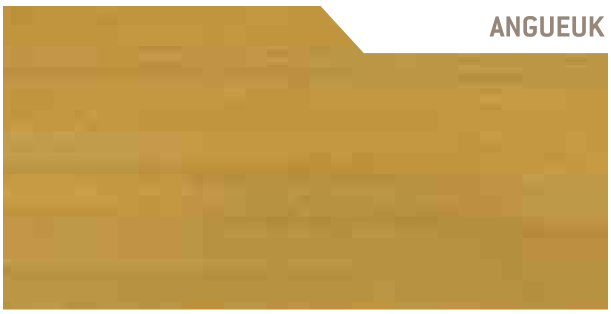
ALEP



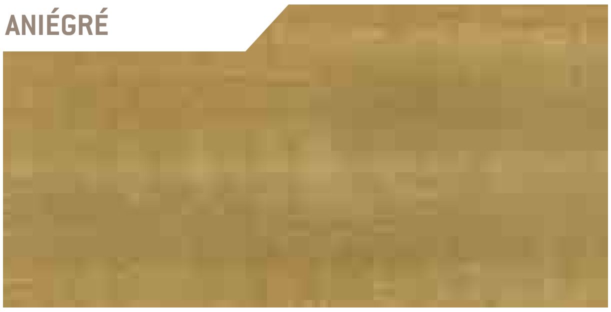
ANDOUNG



ANGUEUK

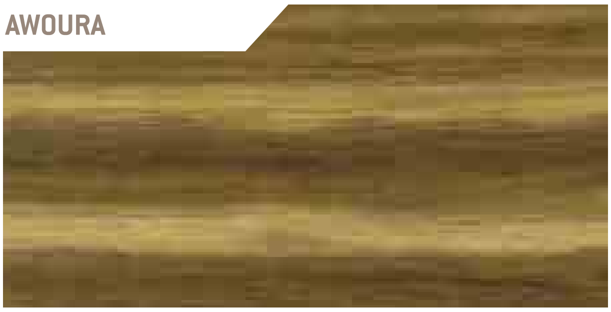


ANIÉGRÉ

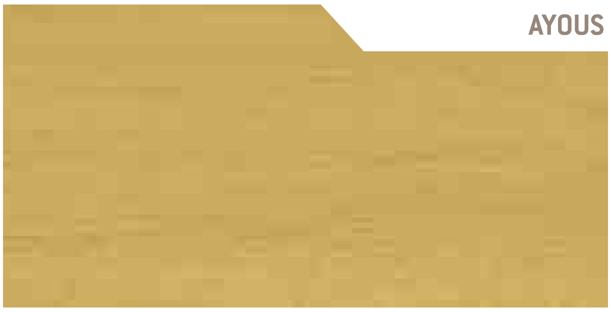


AVODIRÉ

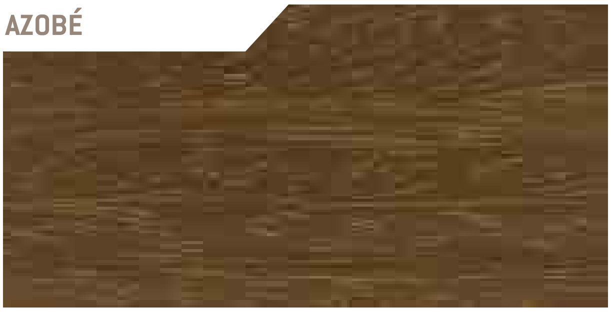
AWOURA



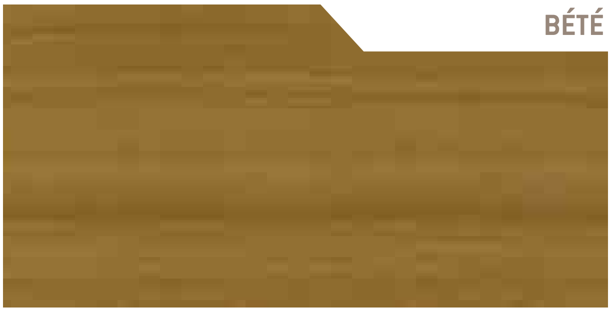
AYOUS



AZOBÉ



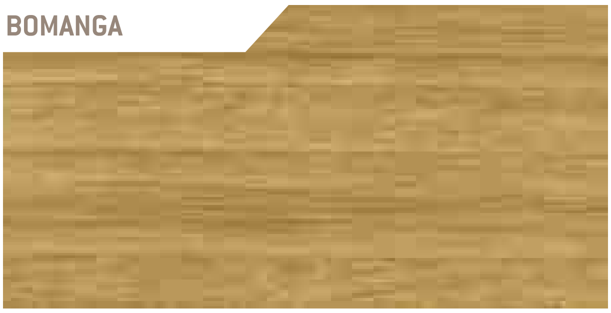
BÉTÉ



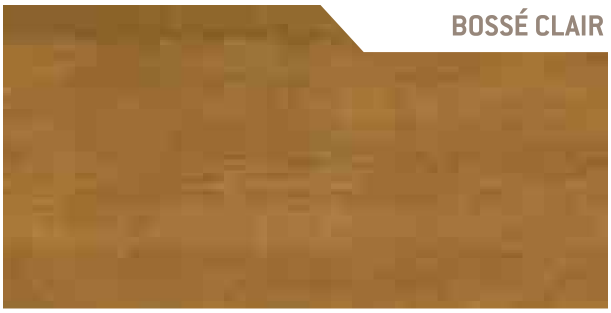
BILINGA

BODIOA

BOMANGA



BOSSÉ CLAIR



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ANNEX 3: AFRICAN SPECIES

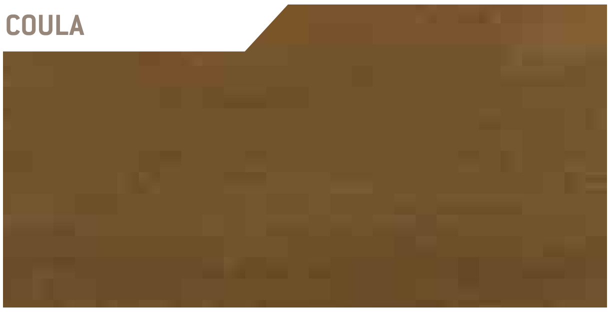
BOSSÉ FONCÉ

BUBINGA

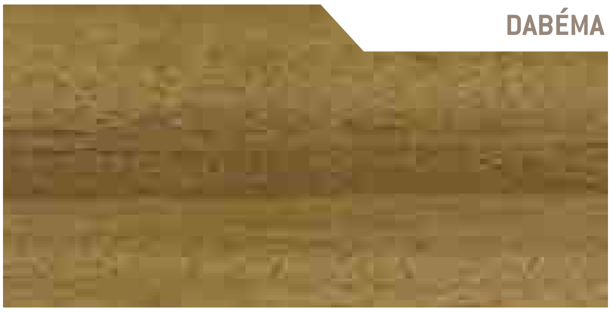
CONGOTALI

CORDIA D'AFRIQUE

COULA

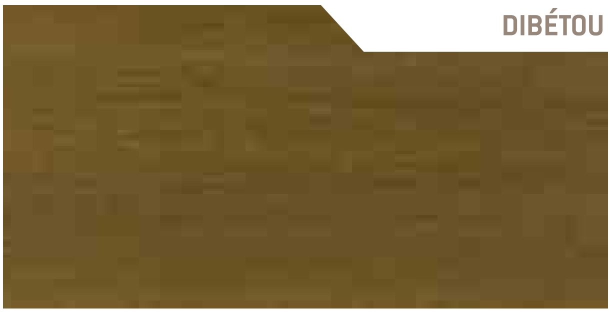


DABÉMA

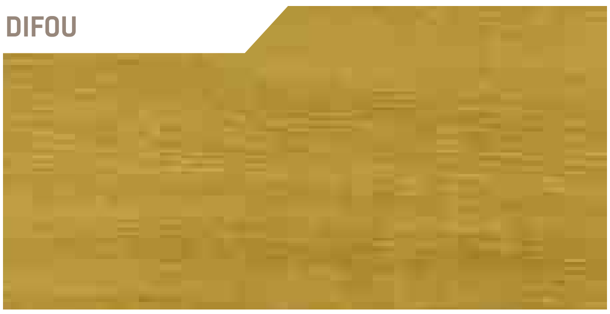


DIANIA

DIBÉTOU

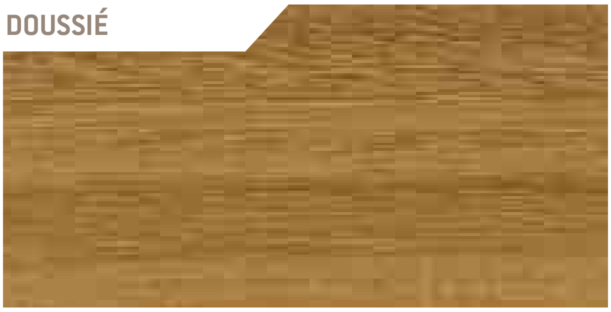


DIFOU



DOUKA

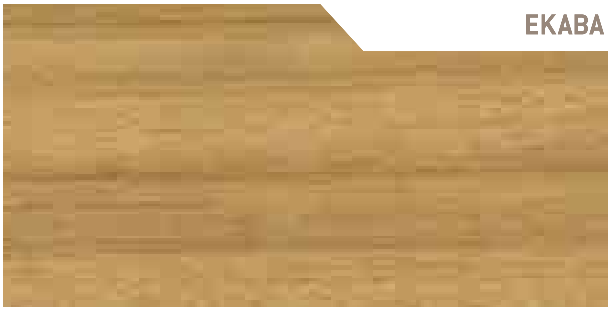
DOUSSIÉ



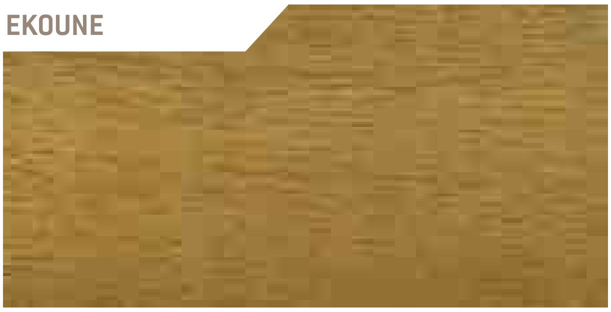
EBÈNE D'AFRIQUE

EBIARA

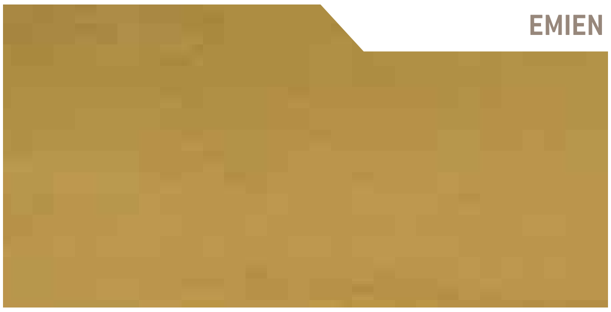
EKABA



EKOUNE

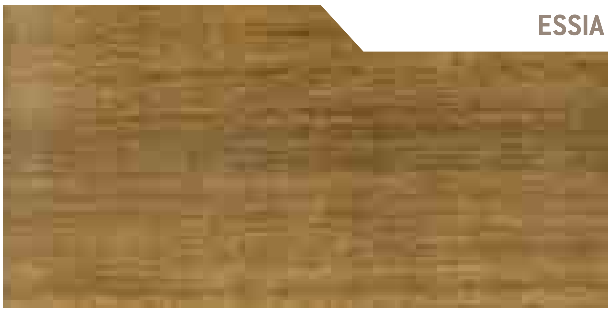


EMIEN



ESSESSANG

ESSIA



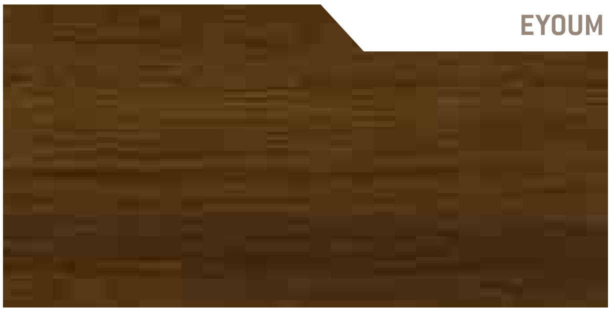
ETIMOÉ

EVEUSS

ANNEX 3: AFRICAN SPECIES

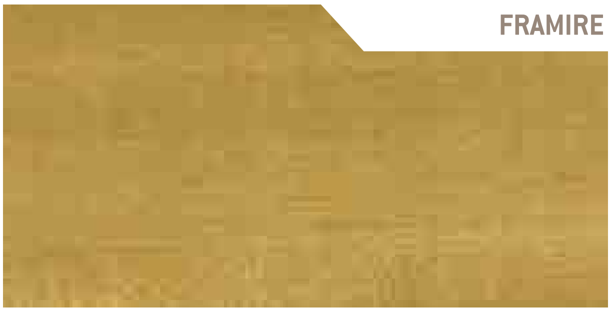
EYONG

EYOUM



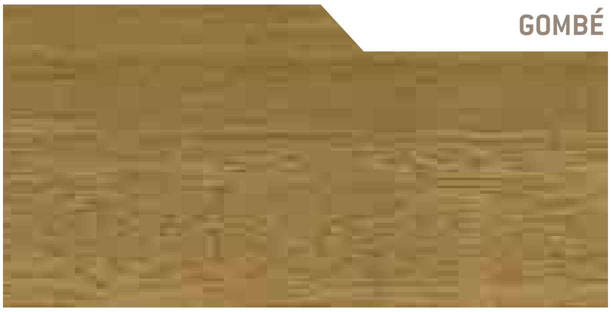
FARO

FRAMIRE



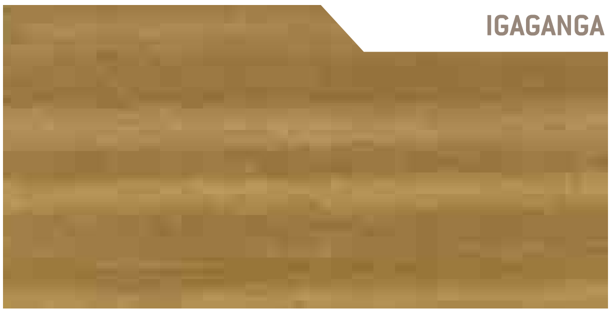
FUMA

GOMBÉ

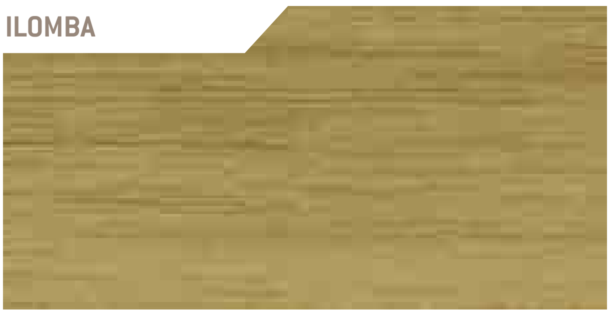


IATANZA

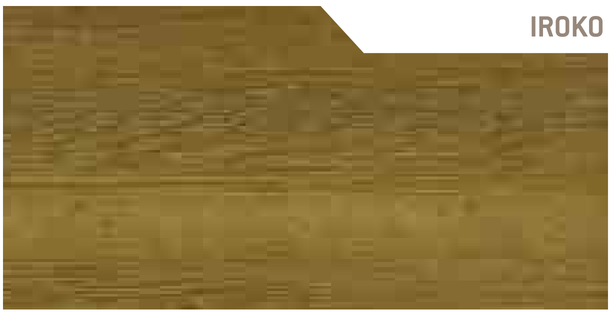
IGAGANGA



ILOMBA



IROKO



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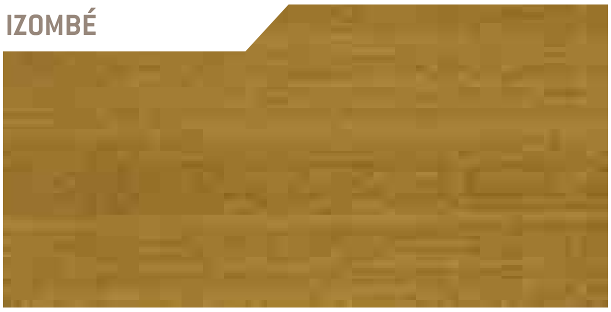
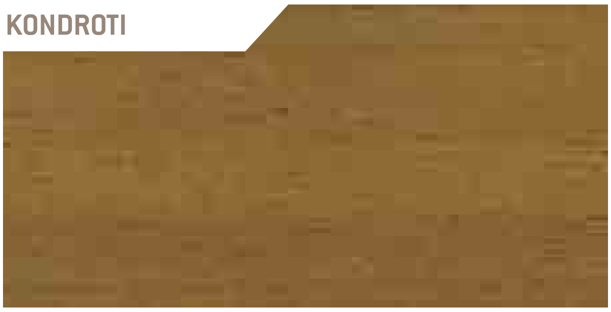
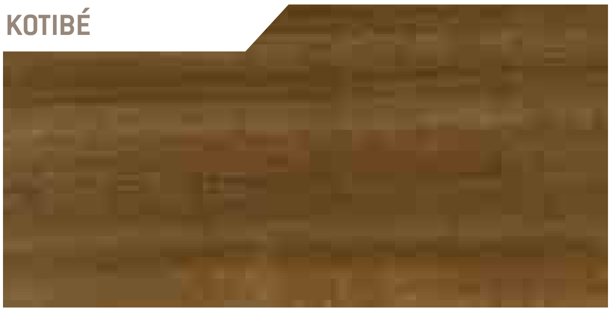
IZOMBÉ



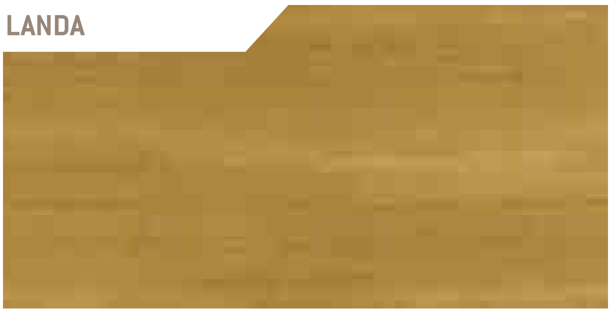
KONDROTI



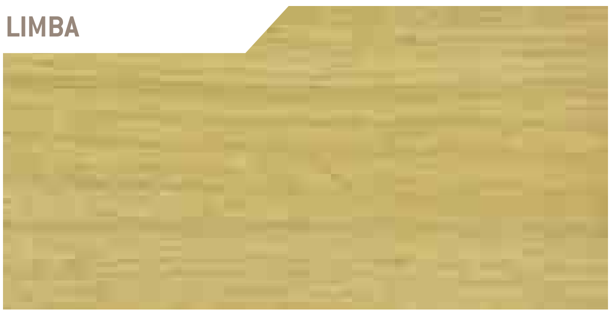
KOTIBÉ



LANDA



LIMBA



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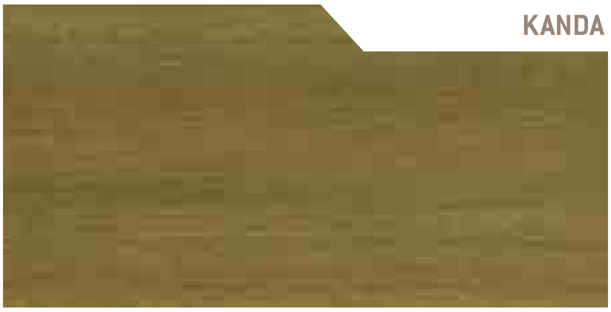
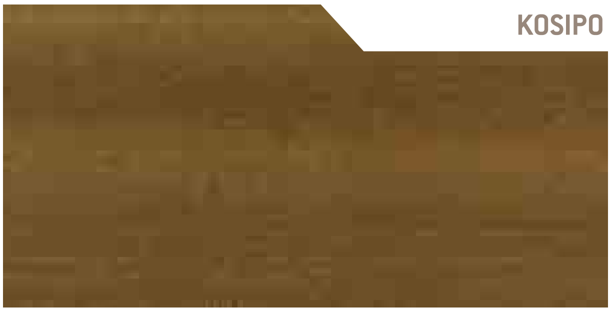
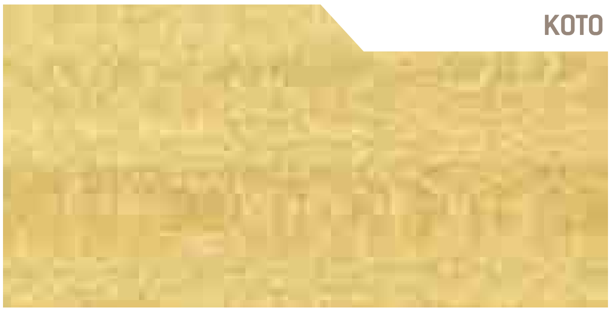


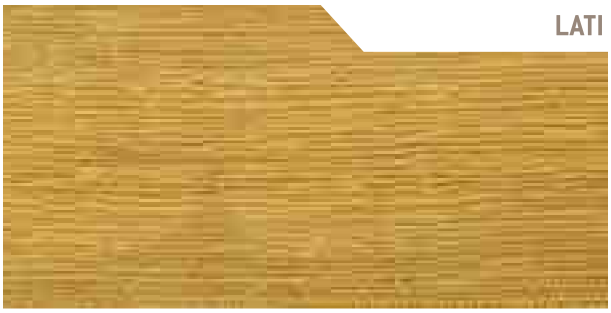
KOSIPO



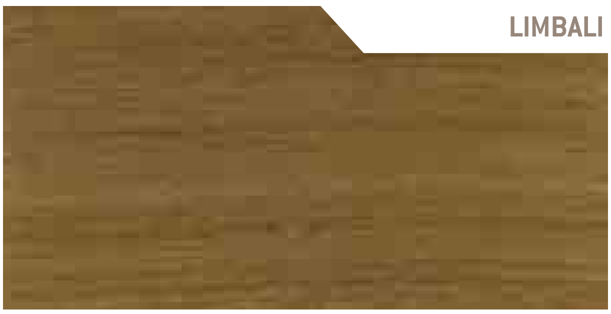
KOTO



LATI

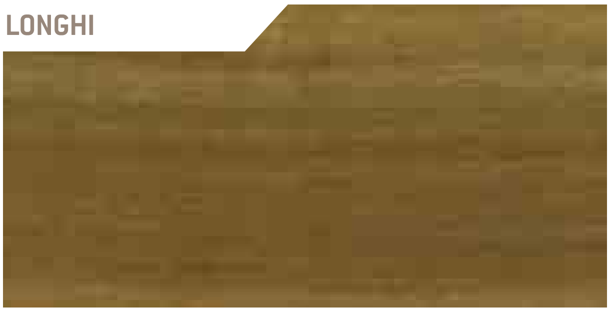


LIMBALI

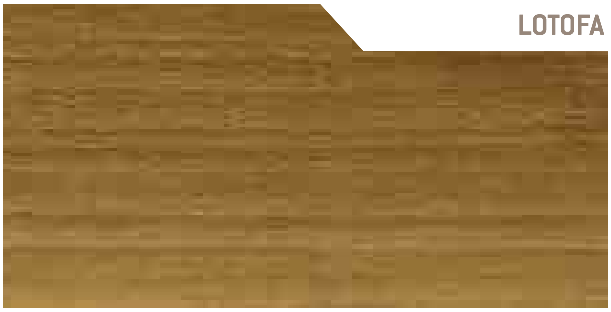


ANNEX 3: AFRICAN SPECIES

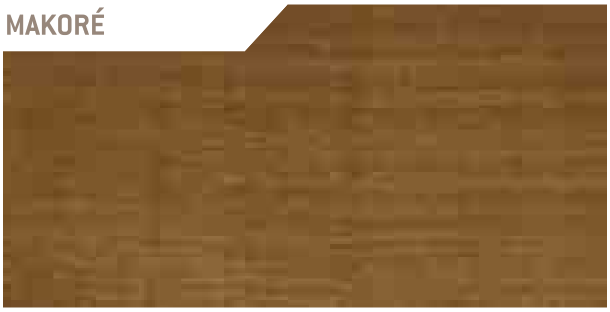
LONGHI



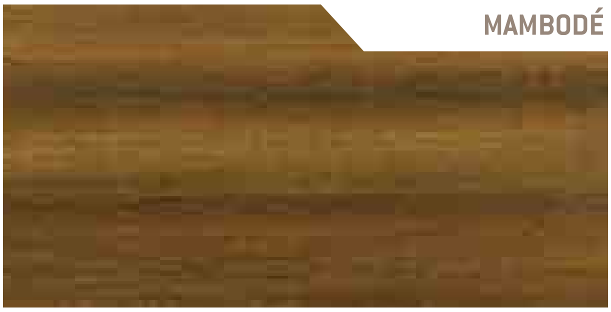
LOTOFA



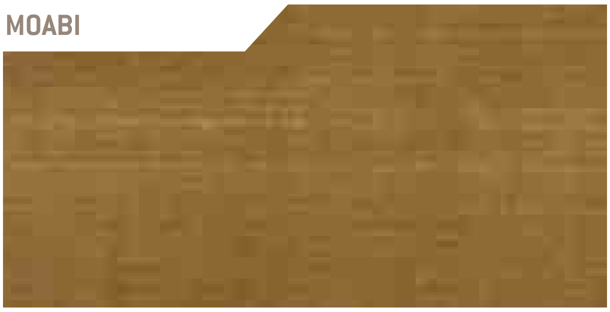
MAKORÉ



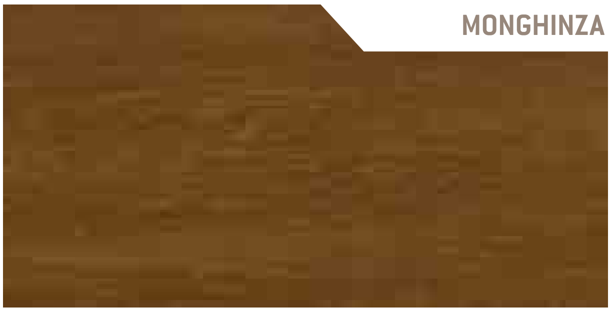
MAMBODÉ



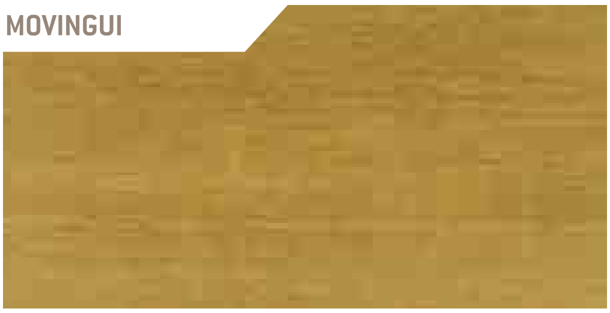
MOABI



MONGHINZA

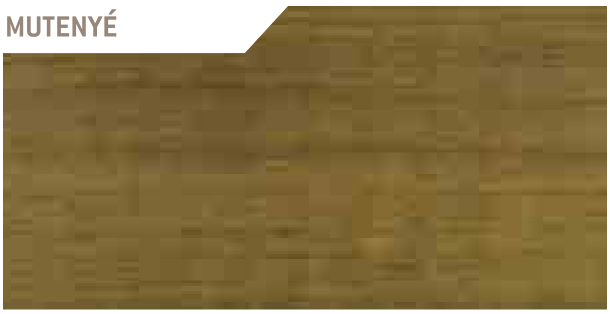


MOVINGUI

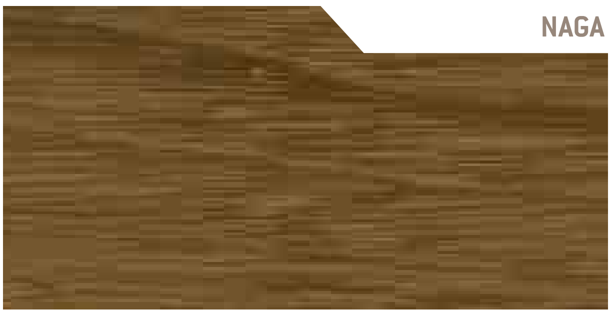


MUKULUNGU

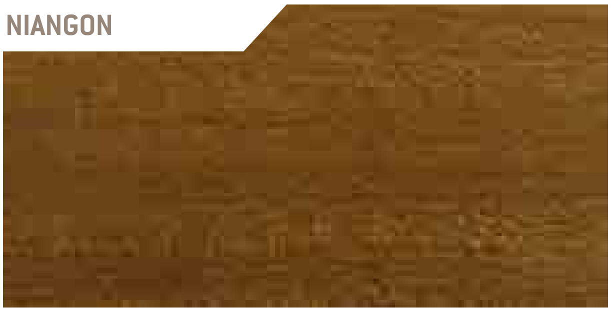
MUTENYÉ



NAGA



NIANGON



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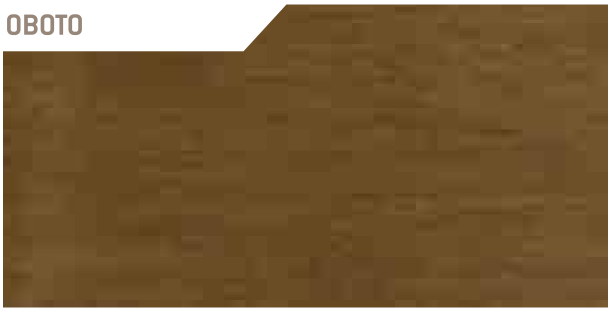
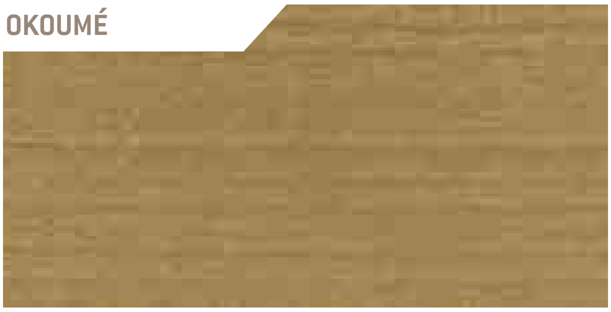
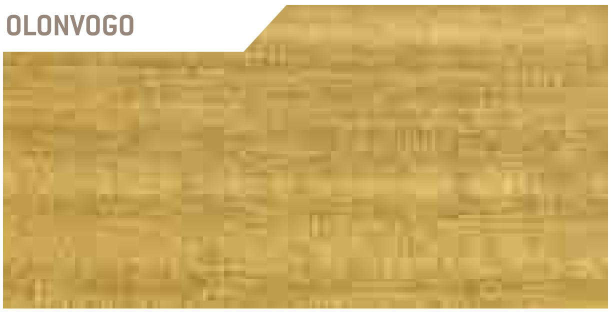


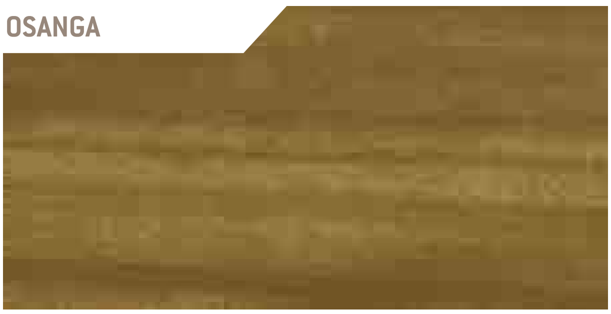
OKOUMÉ



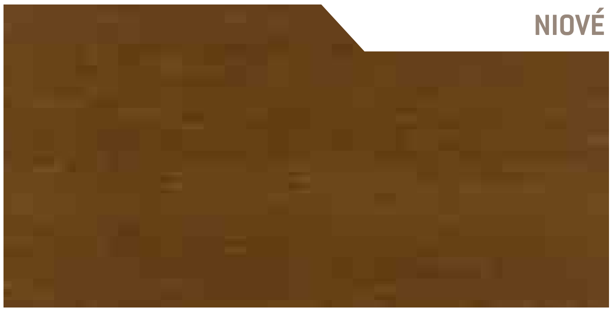
OLONVOGO



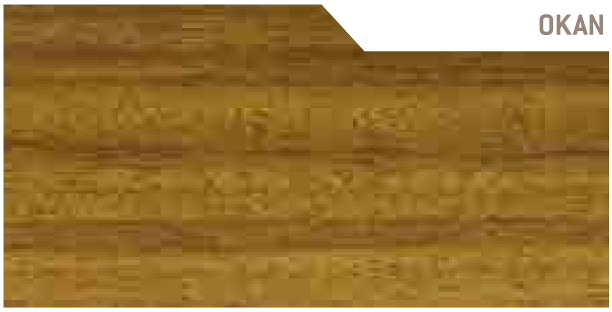
OSANGA



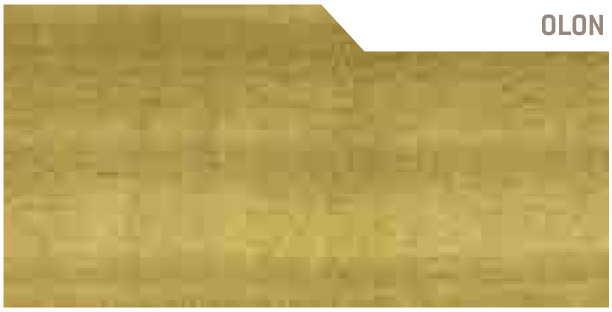
NIOVÉ



OKAN

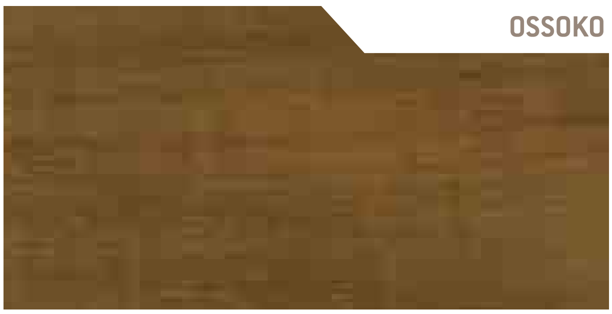


OLON



ONZABILI

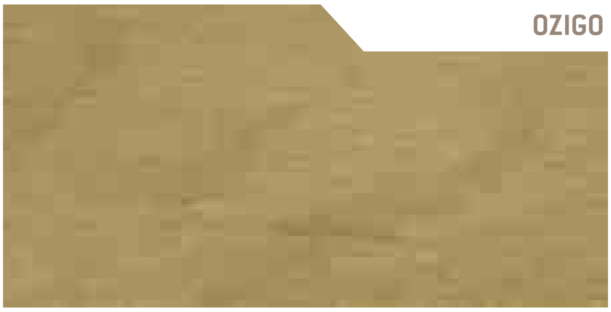
OSSOKO



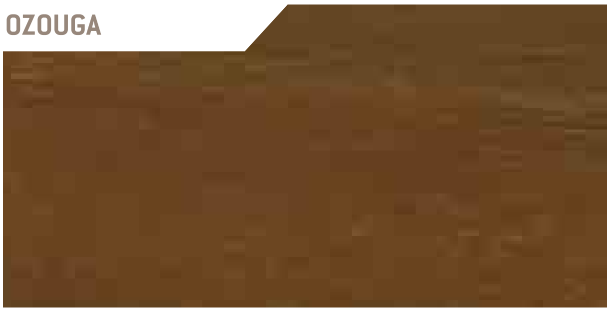
ANNEX 3: AFRICAN SPECIES

OVÉNGKOL

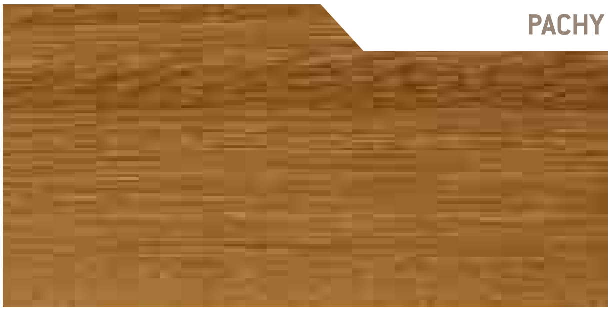
OZIGO



OZOUGA

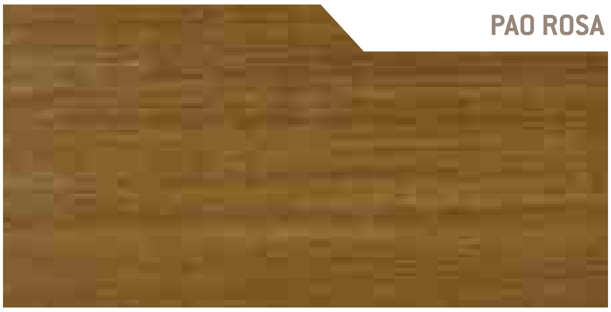


PACHY

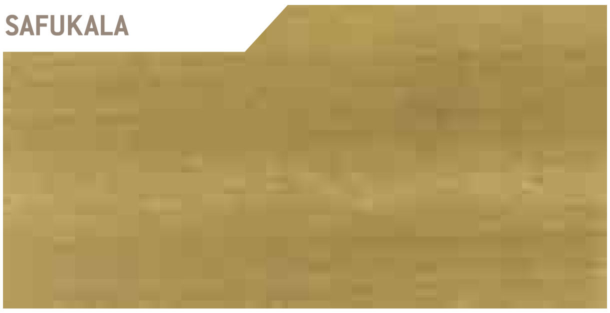


PADOUK D'AFRIQUE

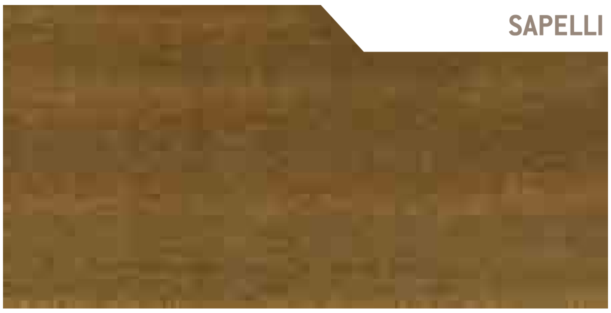
PAO ROSA



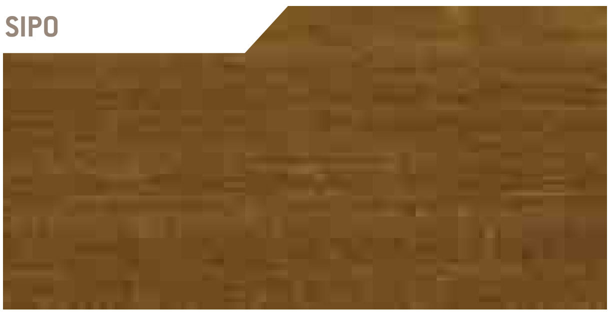
SAFUKALA



SAPELLI

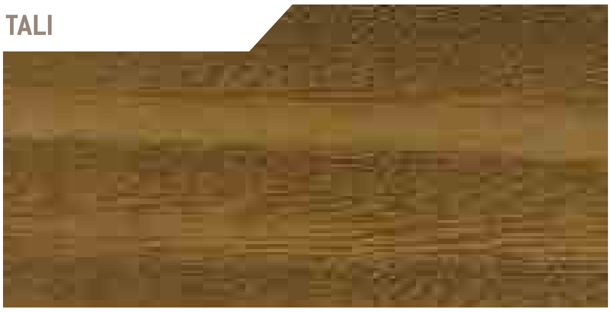


SIPO



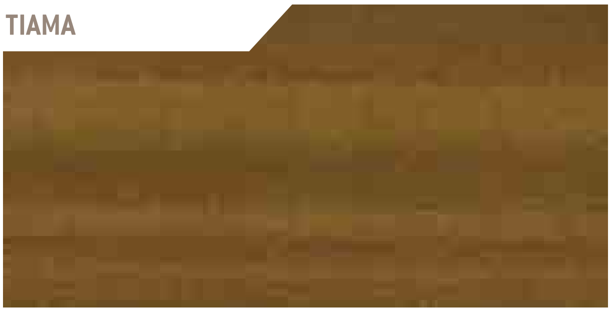
SOUGUÉ

TALI

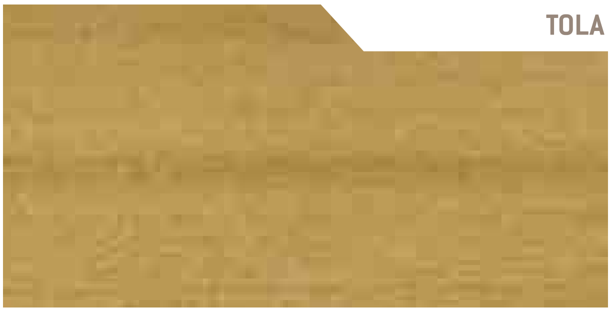


TCHITOLA

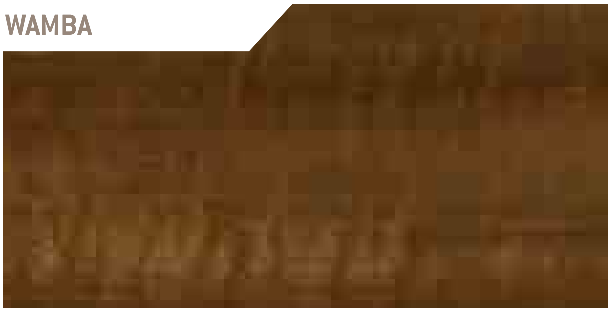
TIAMA



TOLA



WAMBA



WENGÉ

ZINGANA

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THE LEADING AUTHORITY ON TROPICAL TIMBER

USER GUIDE FOR ECO-CERTIFIED AFRICAN TIMBER

African timber is generally recognised as an effective material: resistant, durable, aesthetic, etc., but consumers often do not know about the eco-certifications that implicate the foresters in terms of the economic, social and cultural growth of the producing country, the preservation of biodiversity and efforts to combat deforestation.

The first part of the "User guide for eco-certified African timber in Europe" presents technical information on the tropical timber material, highlighting its exceptional qualities, the stakes of eco-certification and environmental benefits. And in a second part, it provides details - in the form of technical sheets - on the types of structures for which the tropical timber has proven to be ideal and it offers a list of the species that enable them to be built.

This guide is part of an effort to generate awareness among European consumers so that they can choose a species that matches the use, while keeping in mind the consequences on the future of tropical forests and the populations that depend on them.

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