

PERFORMANCE TESTING SUMMARY

TRIED, TESTED AND PROVEN



INTRODUCTION

Accoya® wood is the result of over 80 years research and development. Combining the proven modification technique of acetylation with cutting-edge proprietary technology, this high performance wood is created for demanding outdoor applications; from windows to doors, decking to cladding, bridges to boats.

Wood for Accoya® is sourced from sustainable forests and manufactured using Accsys' patented modification process. Its properties exceed those of the best tropical hardwoods and it can handle the most demanding jobs - even those that are presently only considered feasible with non-sustainable materials.

Accoya® is a highly proven product with testing from many different perspectives on a worldwide basis. Many tests have been conducted in real-world conditions over many years. This summary shows some of these results. Full reports of these and similar tests are available upon request. Many are already posted in the downloads section on accoya.com.



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According to US data source, Accoya® wood can be classified as Class C

LCA AND CARBON FOOTPRINT – CAMCO / TU DELFT

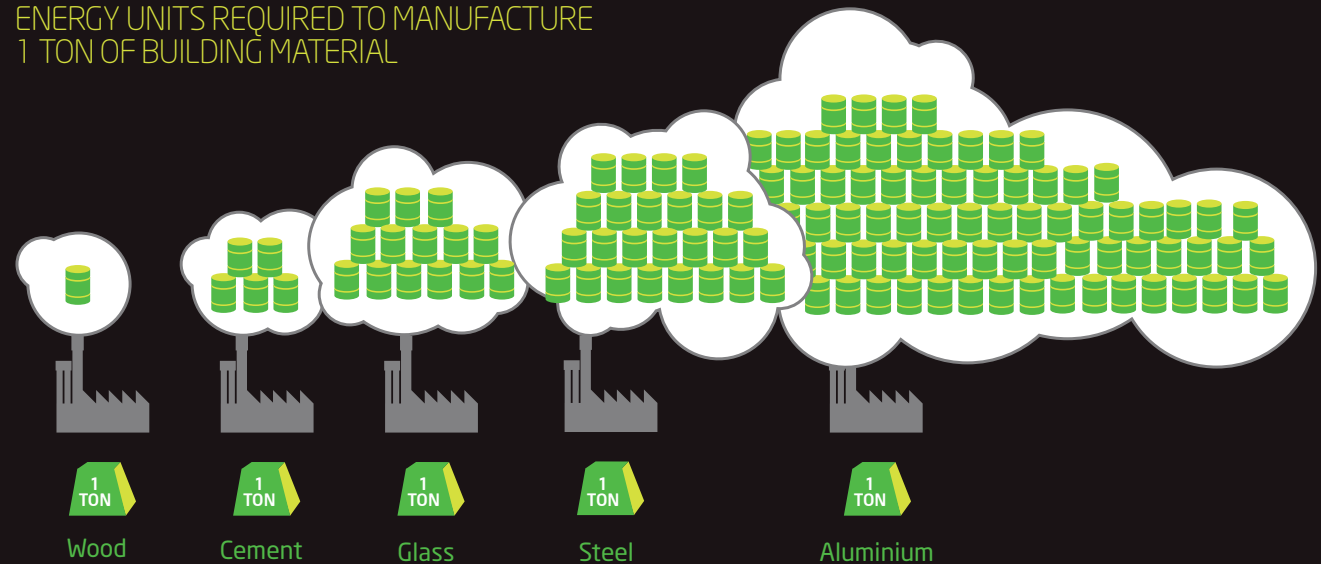
The Carbon Footprint Reports from Camco UK and the Life Cycle Assessments from TU Delft, conducted using ISO 14040 compliant processes, both show that Accoya® wood outperforms competing building materials and is less harmful to the environment.

Independent research and testing has proven Accoya® wood's superior environmental performance.

ACCOYA® WOOD:

- Uses less energy than cement, glass, steel and aluminium when utilised as a building material
- Its manufacture emits less greenhouse gas than other major competing materials such as PVC, aluminium and unsustainably sourced tropical hardwoods when used in typical applications such as window frames
- Outperforms aluminium, spruce and tropical hardwoods like red meranti on cost, maintenance and life span when used as a building material

ENERGY UNITS REQUIRED TO MANUFACTURE 1 TON OF BUILDING MATERIAL



LCA AND CARBON FOOTPRINT – CAMCO / TU DELFT

The Carbon Footprint Reports from Camco UK and the Life Cycle Assessments from TU Delft, conducted using ISO 14040 compliant processes, both show that Accoya® wood outperforms competing building materials and is less harmful to the environment.

A carbon footprint assessment was carried out on Accoya® wood using standard emission factors as referenced in the Camco study in line with the World Business Council for Sustainable Development and World Resources Institute's (WBCSD/WRI) Greenhouse Gas (GHG) Reporting Protocol best practice guidelines (Bhatia and Ranganathan 2004).

This assessment incorporates the six GHGs covered by the Kyoto Protocol: (carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆).

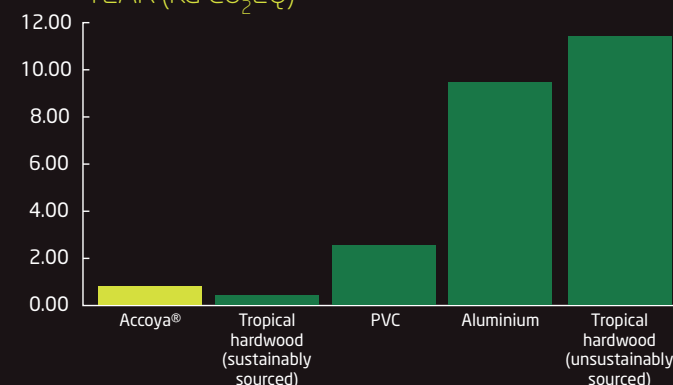
Each of these gases has a different impact on global warming potential, so they are translated into a single unit: carbon dioxide equivalent (CO₂eq). This is the most widely accepted method of reporting all Kyoto GHGs.

The graphs show that in terms of annual carbon footprint, Accoya® wood performs significantly better than metals (steel, aluminium), plastics (PVC), concrete and unsustainably sourced timber. In some cases, sustainably sourced wood has a negative carbon footprint due to the carbon sequestration effect modeled through the PAS (Publicly Available Specification) 2050 guidelines. However, when wood is unsustainably sourced, the annual emissions increase dramatically.

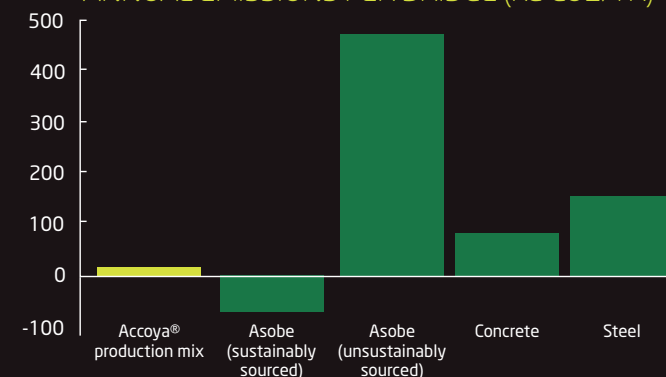
The study we commissioned shows the comparative results of a carbon footprint assessment for the application of Accoya® wood in a pedestrian bridge and a window frame.

Modified wood products based on fast growing timbers, such as Accoya®, have additional benefits which are not included in the carbon footprint assessment. Firstly, the supply of sustainably sourced, certified tropical hardwood is relatively small and secondly, the importation of uncertified, and in some instances illegal, hardwoods is still common practice.

GHG EMISSIONS PER WINDOW FRAME PER YEAR (KG CO₂EQ)



ANNUAL EMISSIONS PER BRIDGE (KG CO₂/YR)



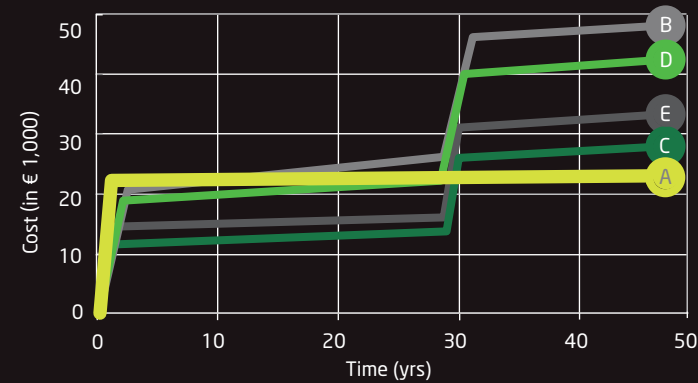
SUPERIOR WHOLE LIFE COST FOR WINDOWS

A study with a Dutch window producer/maintenance company shows that Accoya® is initially more expensive but has a lower total cost than PVC, aluminium, pine and hardwood windows over a reasonable ownership period.

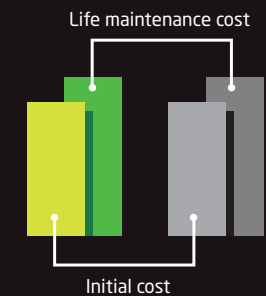
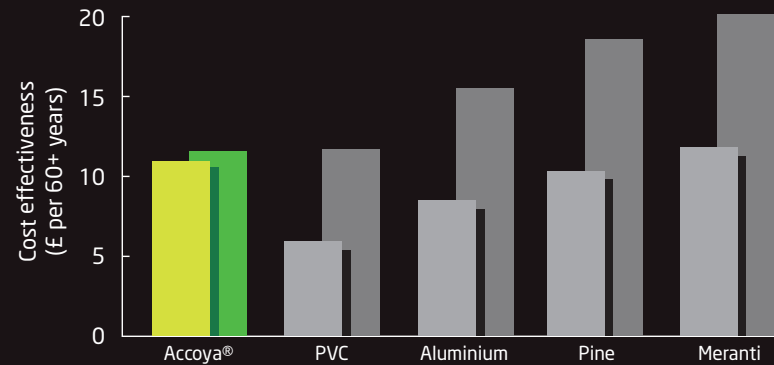
ACCOYA® WOOD:

- Ensures lower maintenance costs
- Ensures longer time between maintenance
- Has extended durability and won't need replacing for 50+ years

LIFE CYCLE COST FOR WINDOW FRAMES IN A TYPICAL DUTCH HOME



A	Accoya® wood	D	Spruce - Hardwood
B	Meranti	E	Aluminium
C	PVC		

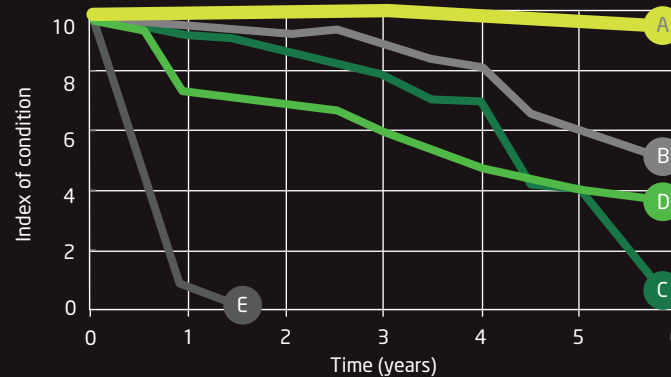


DURABILITY COMPARISON – SCION

Scion, formerly known as New Zealand Forest Research Institute Ltd, undertakes research and science and technology development in forestry, wood products, biomaterials and bioenergy. Scion tested the durability of Accoya® wood against other naturally durable and preservative treated timbers.

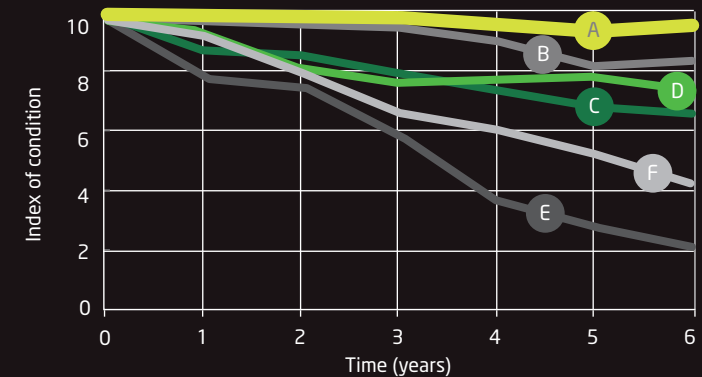
The harsh test site runs exposed timbers in accelerated decay chambers and in exterior ground contact tests at the Whakarewarewa site. The tests have run for six years and show Accoya® performing better than teak, merbau, cypress, cedar and H3.2 (above ground, uncoated horizontal) and H4 (in ground contact) preservative (CCA) treated timbers, proving that Accoya® has the highest possible durability classification.

DECAY RATES OF FUNGUS CELLAR STACKLETS



A	Accoya® wood	D	Merbau
B	CCA H4	E	Radiata Pine
C	CCA H3.2		

DECAY RATED FIELD STAKES



A	Accoya® wood	D	Teak
B	CCA H4	E	Macrocarpa
C	CCA H3.2	F	Cedar



DECAY/INSECT DAMAGE RATING SYSTEM (ASTM D 1758)

- 10 = No decay or insect damage
- T = Discolouration or trace of decay, not positively identified as decay
- 9 = Minor decay, 0-3% of the cross section
- 8 = Lightly established decay, 3-10% of the cross section
- 7 = Well established decay, 10-30% of the cross section
- 6 = Extensive and deep decay, 30-50% of the cross section
- 4 = Deep and severe decay, more than 50% of the cross section
- 0 = Failed

13-YEAR WINDOW L-JOINT TEST – BRE

The BRE (Building Research Establishment) is an independent institute based in Watford, UK. In durability field testing to European Norm (EN) 330:1993 - which parallels America Wood-Preservers' Association (AWPA) E9 - simple mortice and tenon joints (L-joints) are assembled, coated and placed outside, with the coating over the joint deliberately broken to allow typical water ingress. This test represents a worst case scenario for joinery products and requires the coated wood to be exposed to normal environmental factors.

In February 1998, L-joints were installed at the BRE Garston field exposure site (Watford, UK) facing the prevailing south westerly weather on an elevated test rig. The test remains in progress with inspections at regular intervals. The BRE reported: "In simulated accelerated joinery field trials that represent a worst case scenario joinery product by enabling moisture ingress into the joint pine, sapwood wood L-joints acetylated to a slightly lower modification level than Accoya®, after 13 years exposure in the UK are performing very well. The trial indicates that a permeable timber species that is acetylated through the cross section to a durability class 1 level (e.g. Accoya®), would have a grading lower than the reference preservative TnBTO - and thus Accoya® would exceed the biological reference value and would be deemed to provide sufficient protection for long life window joinery."



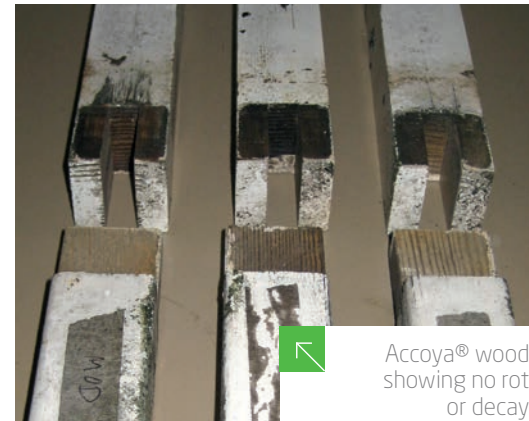
Non-acetylated wood showing major attack



Non-acetylated wood showing rot and decay



Non-acetylated wood showing severe rot and decay



Accoya® wood showing no rot or decay



Accoya® wood showing no rot or decay

60-YEAR SERVICE LIFE - BRE

After running tests and reviewing external and independent data, the BRE concluded that Accoya® wood, provided best design practice is followed, has a service life expectancy of 60 years when used in exterior applications such as windows, doors, cladding and balconies. The BRE stated that Accoya® wood shows excellent durability and stability properties.

“We consider that joinery, cladding and balconies prepared from Accoya® will show significantly improved coating performance properties. If the products are designed and built to the principles of best practice (to minimise moisture ingress and maximise water shedding), factory finished using quality coatings such as Sikksens or Teknos, installed by competent contractors and linked to a recognised best practice maintenance and care package, it will provide exterior wood products of outstanding durability and dimensional stability that would meet a 60-year service life requirement.”



FORMOSAN TERMITE DURABILITY TEST - LSU

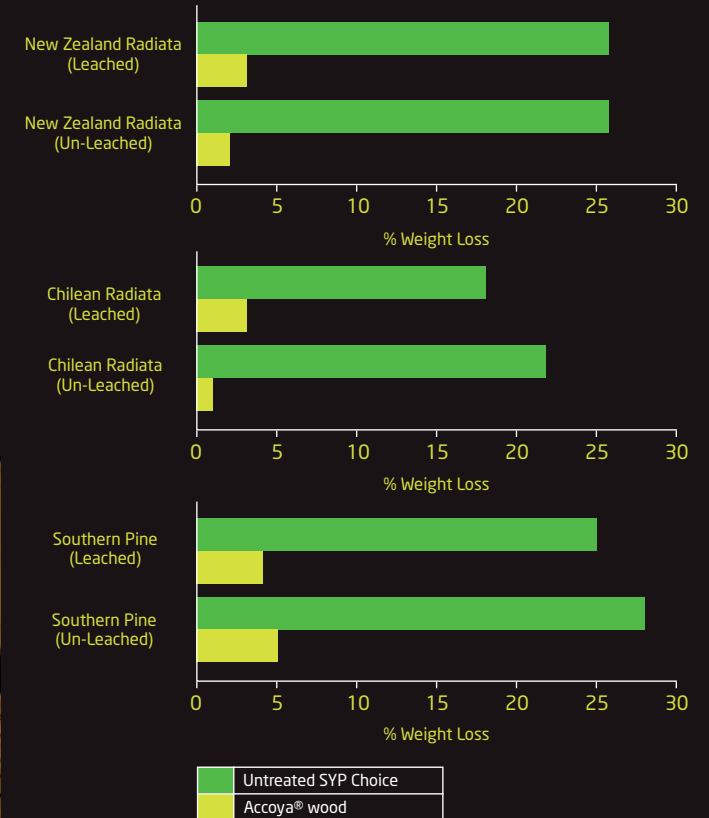
Coptotermes formosanus, known as Formosan termites, are considered one of the world's most aggressive termites. Louisiana State University (LSU) conducted a 99 day formosan termite 'choice' test, using untreated radiata pine and Accoya® wood (2" x 4" lumber).

All four sides of the untreated radiata pine were attacked and left structurally compromised. In stark contrast, Accoya® wood only exhibited slight grazing.

The results of standardised testing show that Accoya® wood was 22 times better than the untreated radiata (when measured by sample weight loss).



LSU FORMOSAN TERMITE TEST RESULTS



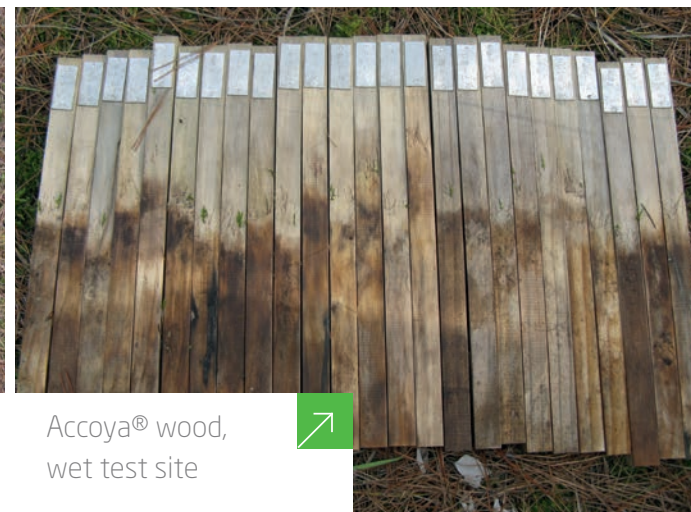
FIELD TEST – KAGOSHIMA TEST SITE, JAPAN

The extreme two year field test conducted was primarily against two different types of termites in two locations of the field site located in Kagoshima, Japan. *Coptotermes formosanus* is present in a dry area and *Reticulitermes speratus* is active in a wet area of the site. Collectively the sites also have an assortment of rot fungi present including white and brown rots.

Unacetylated stakes (both of sugi and radiata) performed poorly. Accoya® wood performed very well and was completely unscathed over the two years.



Non Accoya® wood, wet test site



Accoya® wood, wet test site



Non Accoya® wood, dry test site



Accoya® wood, dry test site

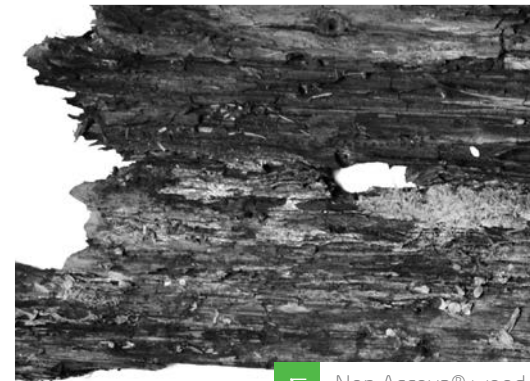
16-YEAR CANAL LINING TEST

Accoya® wood's high performance was proved with a 16-year project test from Waterschap Zuiderzeeland, near the junctions of the N301 and N305 Nijkerk - Zeewolde.

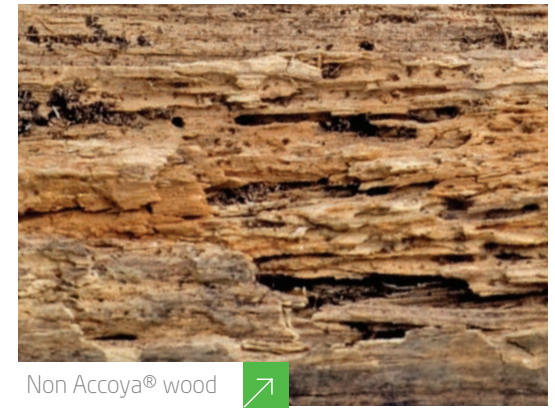
In April 1995, acetylated and control wood was used to line a canal. After 16 years of exposure to fresh water, the acetylated wood showed no sign of rot, decay or fungal damage - highlighting its class 1 durability status.

BS8417 indicates a 30 year service for durability class 1 in this fresh water scenario and Accoya® wood canal linings are showing real life positive results.

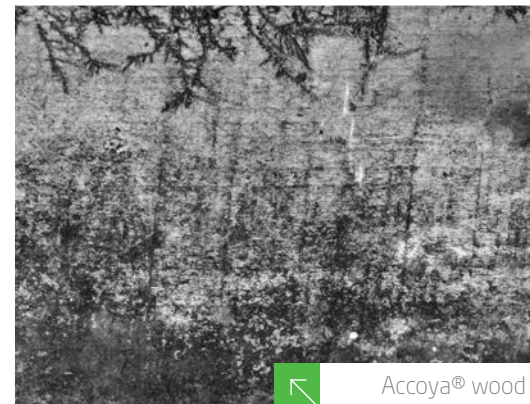
These canal bank conditions are particularly punishing, especially at the waterline, since the wood is exposed to a combination of water, microbe rich soil and air.



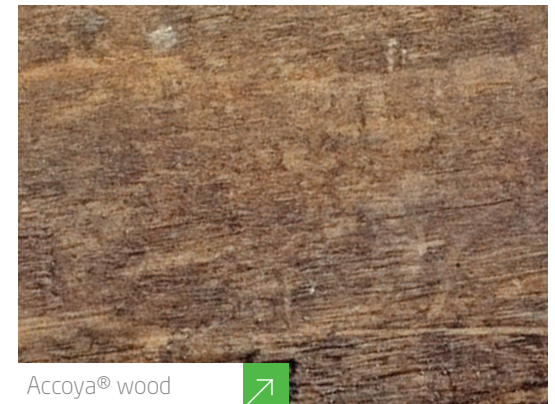
Non Accoya® wood



Non Accoya® wood



Accoya® wood



Accoya® wood

STABILITY, DURABILITY & STRENGTH TESTS – TP

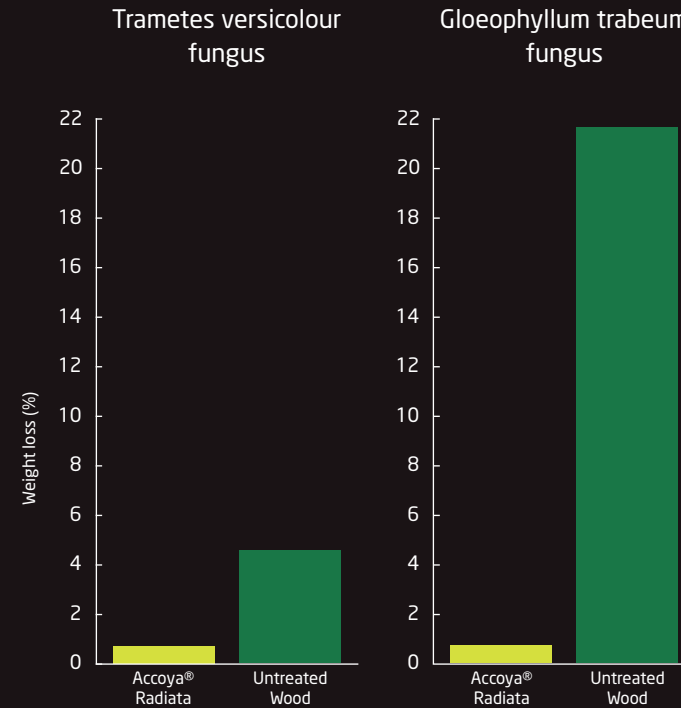
Timber Products Inspection (USA) undertook a number of thorough and independent tests to analyse Accoya® wood's durability, stability and strength performance characteristics in accordance with the USA's Window & Door Manufacturers Association (WDMA) requirements.

Accoya® wood outperformed radiata pine in accelerated decay chambers highlighting its durability. The results showed that Accoya® wood had a very low weight loss percentage for both brown rot (*Gloeophyllum trabeum*) and white rot (*Trametes versicolor*) fungi against such types of decay.

TP also showed that the average MOR and WML values of Accoya® are slightly higher than those of unmodified wood and the average MOE value of Accoya® is slightly lower than that of untreated specimens. Overall, the strength properties of Accoya® are essentially the same as those of the untreated control.

The final test proved that Accoya® meets WDMA's stringent rot resistance requirements, which means it's an ideal choice for windows and doors.

DECAY TEST RESULTS FOR ACCOYA® AND UNTREATED WOOD



TP CONCLUSION

	MOR	MOE	WML
Accoya®	1.23	0.90	1.14
Unmodified	1.00	1.00	1.00

*MOR - Modulus of Rupture (ultimate bending strength)

*MOE - Modulus of Elasticity (Youngs Elasticity)

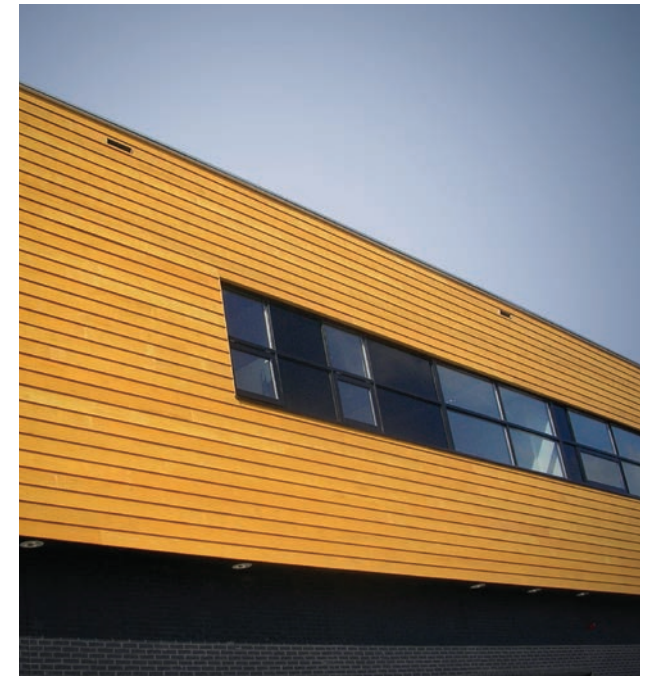
*WML - Work to maximum Load



9.5-YEAR EXTERNAL COATINGS TEST – SHR

Independent testing institute SHR Timber Research in The Netherlands conducted a comprehensive coatings test on Accoya® and untreated wood with opaque paints and stains.

Accoya® wood outperformed all other timbers, with better coating performance and superior coating adhesion in both wet and dry conditions. The white opaque performed extremely well, requiring no maintenance after 9.5 years - which is an important benefit in the long-term life cost of the product and ensures that Accoya® has a superior whole life cost compared to competing materials.



42-MONTH EXTERNAL COATINGS TEST – TRADA

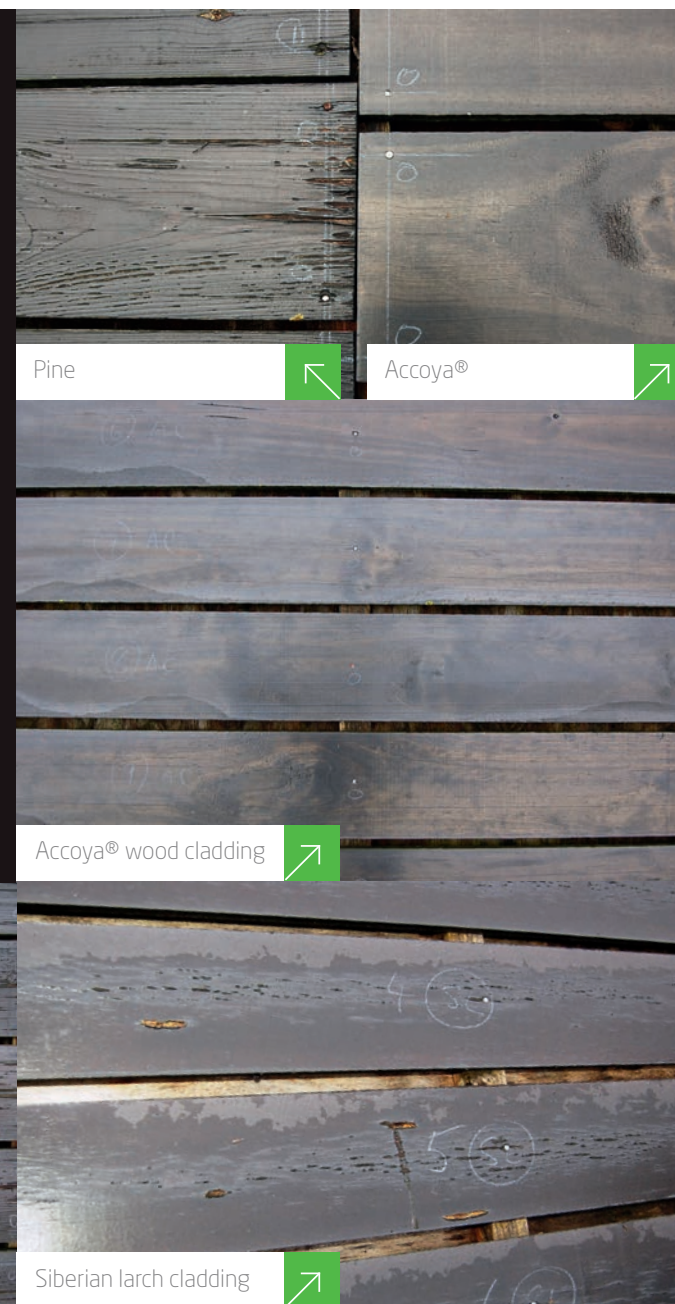
Leading timber research institute, TRADA, was commissioned by Accsys Technologies to provide an update on a series of exposure trials.

The ongoing trials using the same coating began in February 2007 in Buckinghamshire, England and tested Accoya® cladding board's resistance to natural weathering and splitting in comparison to pine and Siberian larch.

After 42-months, Accoya® wood was found to outperform the competing cladding boards in a number of ways - showing excellent coating performance. Pine cladding boards showed severe levels of fissuring, resin exudation, end fissuring, paint peeling over fissures,

shelling, surface checking and board distortion; whilst Siberian larch was found to have extensive surface checking and burst resin pockets.

Accoya® wood, however, had a flat cladding surface with no grain raising, virtually no shelling, cracking, checking or fissuring. External dirt was easily cleaned off revealing a sound clean surface with no rot, decay or coating issues. This harsh test proves that Accoya® wood has superior coating performance compared to many competing materials.



Pine

Accoya®

Accoya® wood cladding

Pine cladding

Siberian larch cladding

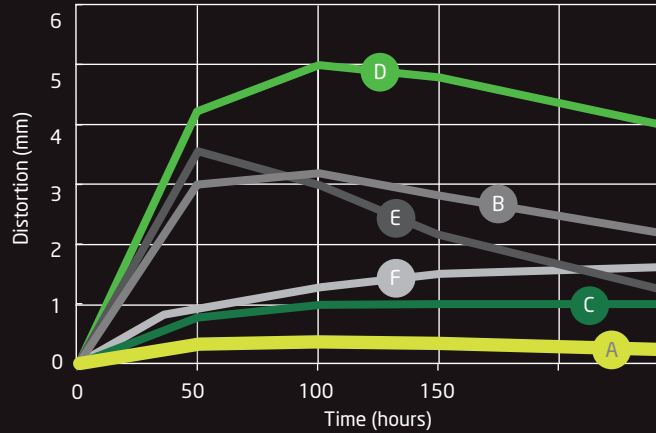
DIMENSIONAL STABILITY TEST - TRADA

Leading timber research institute, TRADA, tested the stability of Accoya® wood against other widely used cladding materials by exposing boards to a high humidity environment and letting them acclimate.

TRADA found that Accoya® wood had exceptional stability and stated that Accoya® used for cladding boards could increase from standard 150mm wide profiles to 200mm when used externally.

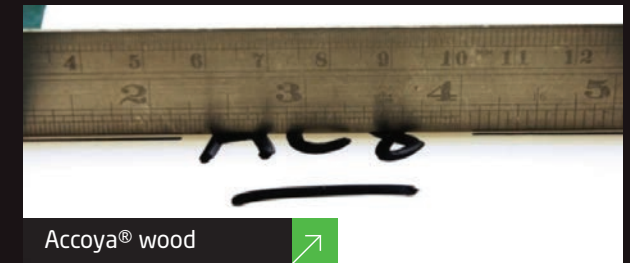
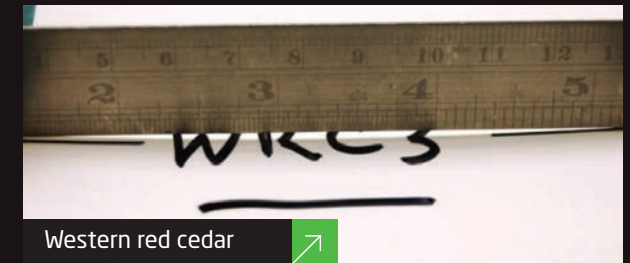
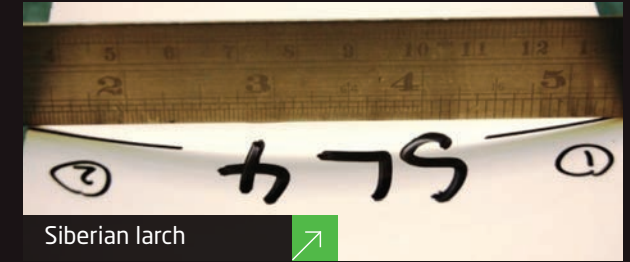
This increased width specification board shows Accoya® wood's design flexibility and superior performance when compared to western red cedar, larch and pine.

TRADA STABILITY TEST GRAPH



A	Accoya® wood	D	Siberian larch
B	European larch	E	Pine
C	Western red cedar	F	Thermowood

COMPARATIVE CUPPING OF CLADDING PROFILES



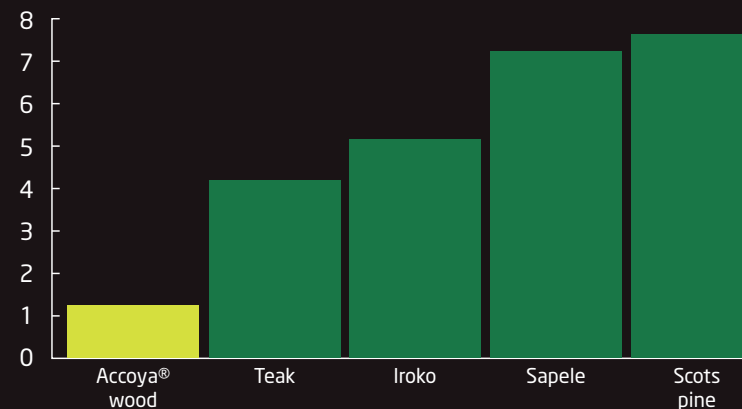
DIMENSIONAL STABILITY TEST – SHR

Leading Dutch timber research institute, SHR, undertook a series of robust tests to evaluate the dimensional stability of Accoya® wood.

Accoya® wood outperformed a wide range of competing timber products such as ipe, teak, selangan, Japanese cypress, western red cedar, dark red meranti, radiata pine and Japanese cedar. This test proves Accoya® wood is ideal for exterior applications like windows, doors, cladding, decking and large structures.

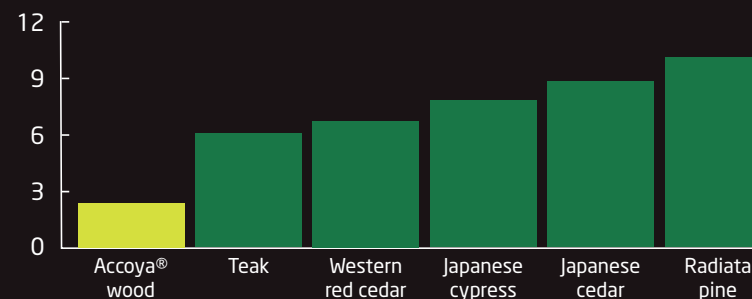
Test on teak, iroko, sapele and scots pine have been extracted from published data: Physical and related properties of 145 Timbers
Jan F. Rijdsdijk and Peter B. Laming
Kluwer Academic Publishers
ISBN 0-7923-2875-2

TANGENTIAL SHRINKAGE* (%)



*typical tangential shrinkage from fully soaked to oven dry - the most extreme laboratory test

VOLUME SHRINKAGE (%)



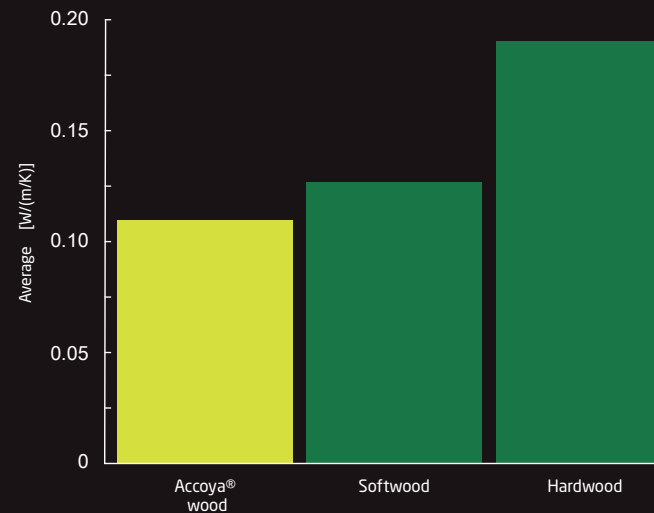
IMPROVED THERMAL PERFORMANCE

Buildcheck, a BFRC (British Fenestration Rating Council) approved assessment body, has proven that a window's U Value can be significantly improved merely by changing the frame substrate from traditional hardwood or softwood to Accoya® wood. This simple change can also improve the window's overall energy rating by one band, for example a C to a B. Testing to Dutch and German national standards by IFT Rosenheim provides a declared thermal value for Accoya® of λ 0.120 W/(m/k). Testing to UK and Nordic national standards determines the thermal value is λ 0.113 W/(m/k).

ACCOYA® WOOD:

- 17% more thermally efficient than typical softwoods
- 40% more thermally efficient than typical hardwoods
- Windows have achieved A rated status under the BFRC energy rating system

COMPARISON WITH OTHER SPECIES



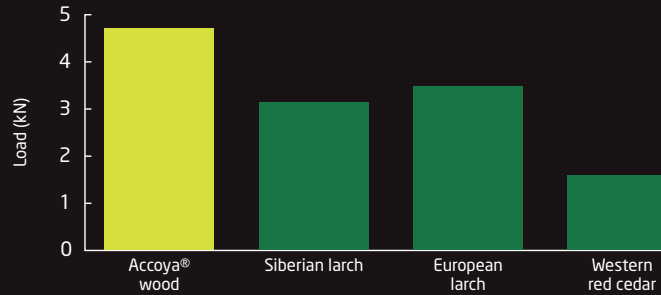
HARDNESS & WEAR TEST – TRADA

Independent testing from leading timber research institute, TRADA, proved that Accoya® wood can withstand harsh, abrasive environments.

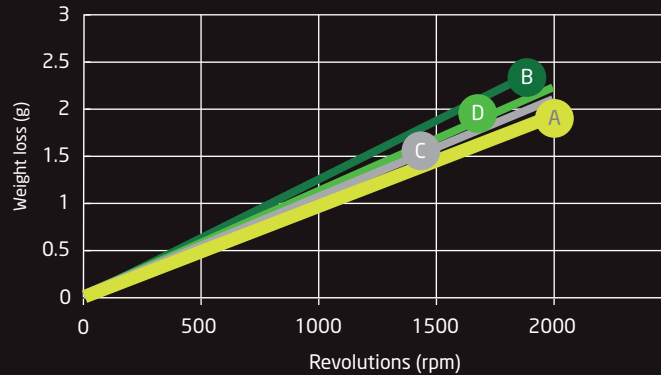
TRADA's testing showed that hardening that occurs as a result of the Accoya® process results in greater resistance to indentation than western red cedar and two types of larch. This is particularly useful when making specification choices for cladding and ground floor exterior products.

Separate scuffing and mechanical abrasion tests carried out by TRADA show that Accoya® wood is just as good, if not better than the two types of larch, and significantly better than western red cedar.

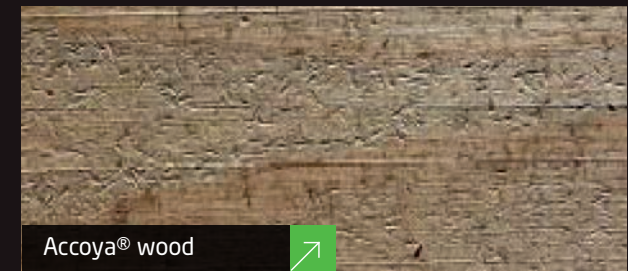
TRADA MEAN HARDNESS



TABER ABRASION TEST



A	Accoya® wood	C	European larch
B	Western red cedar	D	Siberian larch



FLAME SPREAD TEST AND SMOKE DEVELOPED TEST - SWRI

In March 2009, Southwest Research Institute undertook Flame Spread Tests and Smoke Developed Tests in accordance with the standard test method for surface burning characteristics of building materials NFPA 255 (ANSI, UL 723 & UBC 8-1).

The conclusion of the Flame Spread Test results is that Accoya® wood can be classified within the range of standard timber species and achieves Class C in this US rating system.

Wood / Species	Flame Spread Index*
Lodgepole pine	93
Accoya®	95
Oak	100
Sitka spruce	100
Maple	104
Birch	105
Cottonwood	115

* data source - USDA - United States Dept of Agriculture Wood Handbook. Lower numbers equal a lower flame spread.

Flame Spread Classification	Flame Spread Rating or Index	Wood / Species	Smoke Developed Index*
Class I (or A)	0 - 25	Yellow cedar	90
Class II (or B)	26 - 75	Oak	100
Class III (or C)	76 - 200	Eastern white pine	122
		Accoya®	155
		Lodgepole pine	210
		Western red cedar	213

* data source - USDA - United States Dept of Agriculture Wood Handbook. Lower numbers equal less smoke.

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For more information and to download the latest test reports on Accoya®'s outstanding performance, tested by leading independent institutes, then visit the download section at www.accoya.com



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Accsys Technologies accepts no liability for any defect, damage or loss that may occur where such written instructions and guidelines are not adhered to.

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International Timber

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Brochure version TW-EUR/EU-Sep 12.
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UK Patent No.2 456 915
South Africa Patent No. 2010/05240