accoya®

PERFORMANCE TESTING SUMMARY

CONTENTS

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 download section on accoya.com.

TRIED, TESTED AND PROVEN

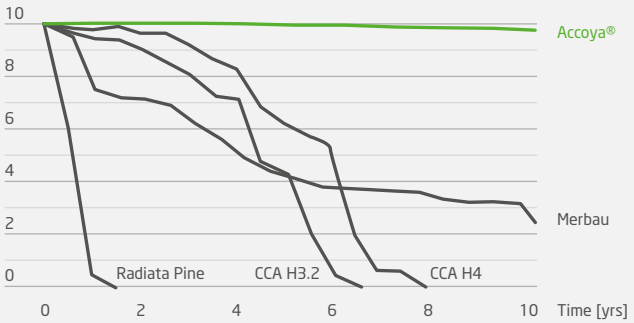
DURABILITY COMPARISON – SCION

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.

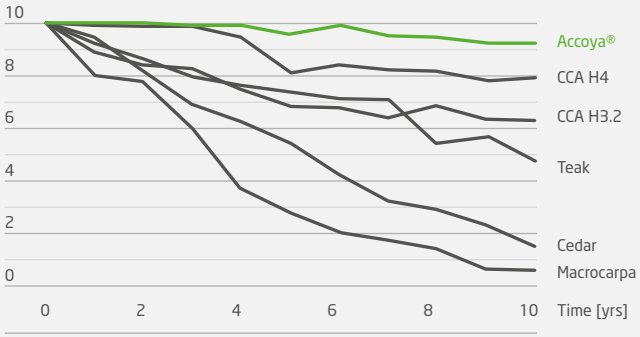
The harsh tests run exposed timbers in accelerated decay chambers and in exterior ground contact tests at the Whakarewarewa site. The tests have run for ten years and show Accoya® performing better than teak, merbau, cypress, cedar and H3.2 (above ground, uncoated horizontal) and H4 (in ground contact)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

Accoya® stake after 10 years

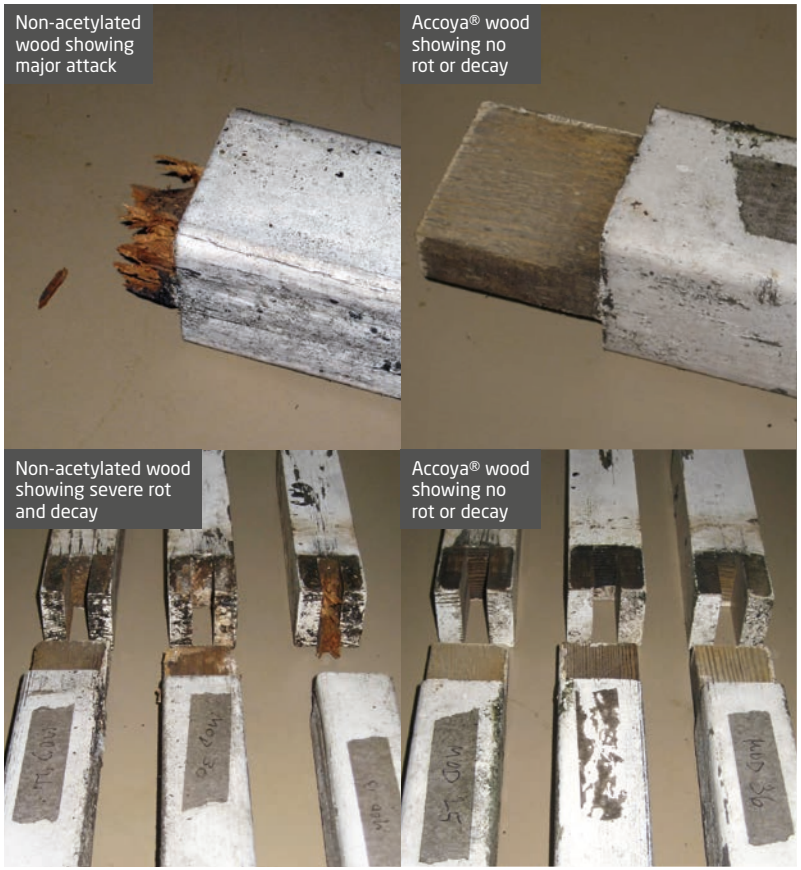
DECAY RATES OF FUNGUS CELLAR STAKELETS



DECAY RATED FIELD STAKES



Decay/insect damage rating system (based on 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



15-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 water ingress that might be encountered if a joint is open, damaged or poorly maintained. 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 acetylated wood condition is unchanged and continues to look good, while the unmodified wood has degraded completely.

* Test report from 2013

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 15 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."

bre

3.5-YEAR FACE LAMINATED ACCOYA WINDOW TEST – BRE

Two window frames made from face laminated Accoya® / pine / pine wood were installed in the BRE Window Joinery Test building in June 2012, facing South to maximise solar irradiance. One window frame was coated with a translucent finish, and one with an opaque white finish.

Additionally, a range of durability and dimensional stability tests have been completed at IFT Rossenheim, Germany according to standard methods for 2.0m length scantling stability and adhesive bond delamination resistance. The tests have been completed for Accoya®-Pine-Pine and Accoya®-Spruce-Spruce combination. The scantlings met both requirements. Reports are available upon request.

AFTER 36 MONTHS OF EXPOSURE, THESE FRAMES WERE INSPECTED ON:

General condition
Appearance excellent

Joint condition
Excellent, joints tight, coating intact, no evidence of movement or opening

Bead condition
Excellent

Coating condition
Excellent, bright, no signs of deterioration or discoloration

Operation
Movement of opening light was easy

This resulted in an 'excellent' overall rating (10/10).

SUPERIOR WHOLE LIFE COST FOR WINDOWS

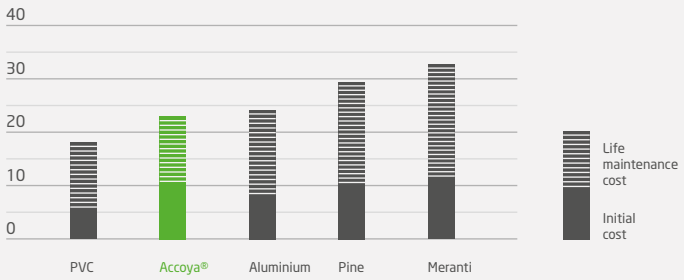
A study with a Dutch window producer and a maintenance company shows that Accoya® is initially more expensive but has a lower total cost than PVC, aluminium, pine and hardwood windows over the life of the home.

ACCOYA WOOD:

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

COST EFFECTIVENESS PER WINDOW FRAME

[in £ per 60+ year]



LIFE CYCLE COST FOR WINDOW FRAMES IN A TYPICAL DUTCH HOME

[in €1,000]

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. This position has been positively corroborated by TRADA and Heirott Watt University / Imperial College London conducting similar service life reviews.

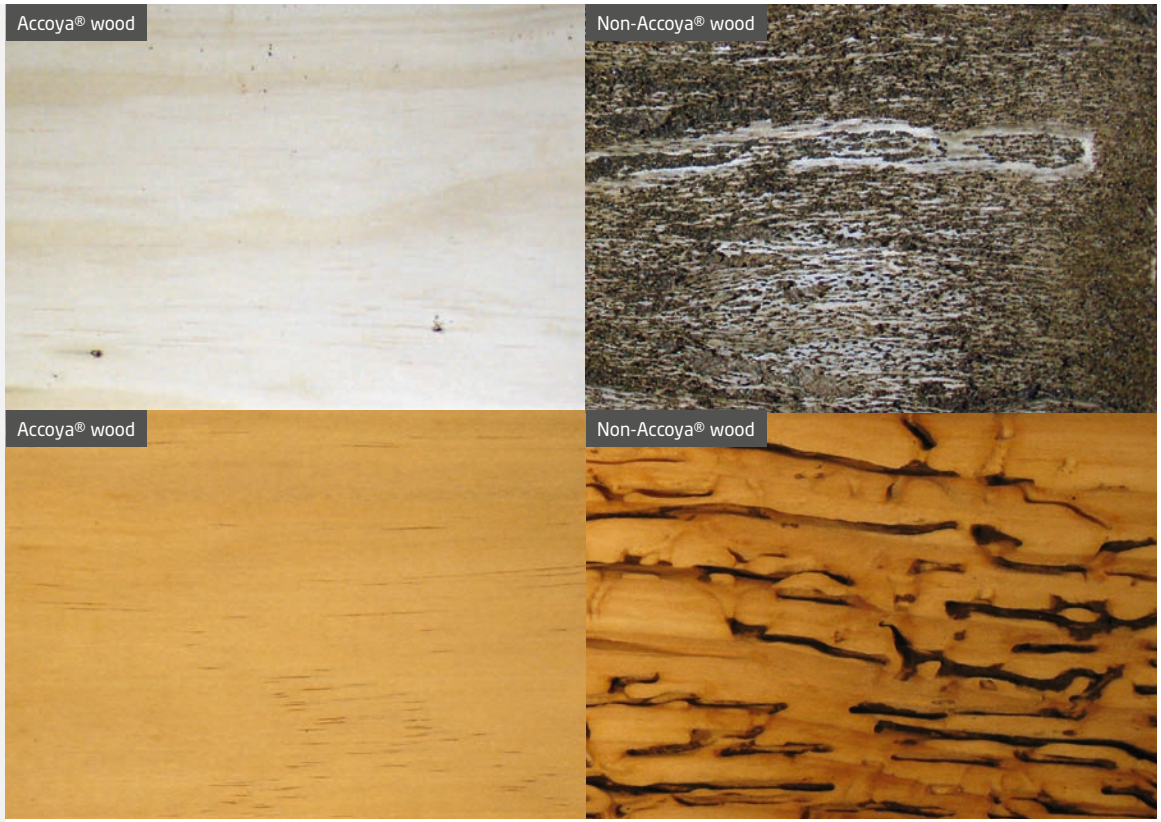
"We consider that joinery, cladding and balconies prepared from Accoya® will show significantly improved coating performance properties. If the products are designed and built to the principles of best practice (to minimise moisture ingress and maximise water shedding), factory finished using quality coatings such as Sikkens 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

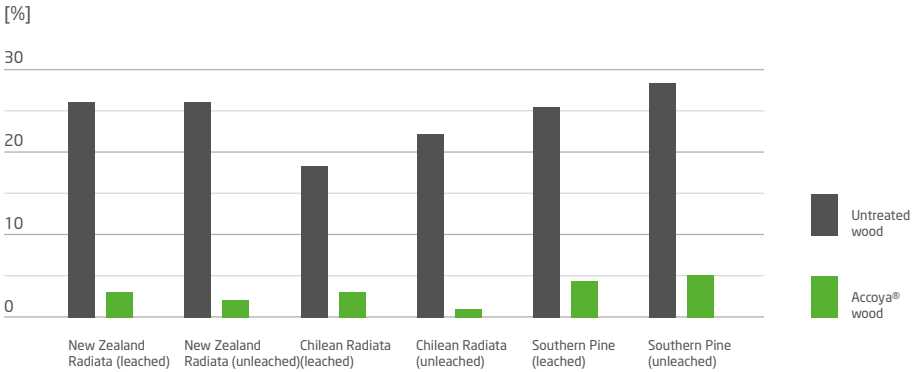
Coptotermes formosanus, known as Formosan termites, are considered one of the world's most aggressive termite species. Louisiana State University (LSU) conducted a 99 day Formosan termite 'choice' test, using untreated radiata pine and Accoya® wood (2" x 4" lumber).

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).

Additional testing by TPI at their exposure sites in Gainesville Florida and Cost Rica demonstrate that Accoya® performance exceeds that of high quality (FEQ) teak. The results were developed over a 5 year field trial period in accordance with AWPA E7-09 in ground stake test and AWPA E18-06 ground proximity test. Performance level was used to support the qualification of Accoya® for use in termite zones and 'in ground' application in the ICC ESR-2825 which confirms Accoya® decking compliance with US Building Code.



WEIGHT LOSS IN LSU FORMOSAN TERMITE TEST



FIELD TEST – JWPA KAGOSHIMA TEST SITE, JAPAN

The extreme field test conducted was primarily against two different types of termites in two locations of the field site located in Kagoshima, South Japan. The site is used by JWPA for assessment on the basis of the warm and wet climate, coupled with presence of Coptotermes formosanus in the 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.

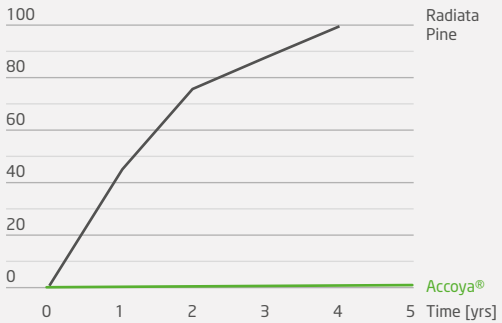
After 5 years of testing, no signs of termite attack were detected on any Accoya® test specimen. At the five year mark for the decay tests, the Accoya® is still completely unscathed, where nearly all untreated bait stakes of radiata pine, used as controls and typically changed each year were so badly decayed that only the portions above ground remained.


Accoya® wood wet test site


Non-Accoya® wood wet test site

FIELD TRIAL EXPOSURE TO C. FORMOSANUS

[mean rating: 0=sound, 100=collapse of stake]




Accoya® wood dry test site


Non-Accoya® wood dry test site

JWPA ACCREDITED CERTIF. NO. D-1001

TERMITE DURABILITY TEST AUSTRALIA – AFRC

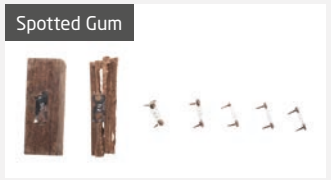
Mastotermes darwiniensis is the most destructive species of Australian termite and active north of the Tropic of Capricorn Hazard Class 3 above ground testing was set up in Northern Territory, Australia according to the AWPA protocol by the Australian Forest Research Company.

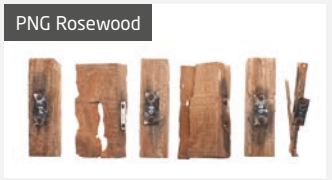
At the conclusion of the field trial all test specimens had evidence of contact by M. darwiniensis, and all untreated Eucalyptus nitens bait-wood, used as a susceptible and attractive food source for maintaining the presence of termites in exposure containers, had been destroyed. The mean mass loss of the untreated radiata pine sapwood was 95%.

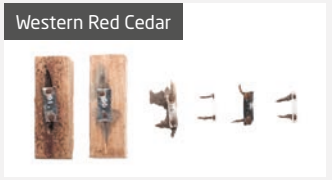
All four of the naturally durable reference hardwood timber samples were significantly attacked by M. darwiniensis, with mean mass losses ranging from 49% to 100%. The PNG Rosewood was the most resistant to attack, whilst all of the American white oak test specimens were destroyed.

The performance of the Accoya® Radiata was markedly superior to that of all the naturally durable reference hardwood timber samples. The mean mass loss was 8.5%. Accoya® Radiata would be expected to perform well, and to a much higher level than timbers with equivalent natural durability to those species investigated in this work, against termites in all regions of Australia.

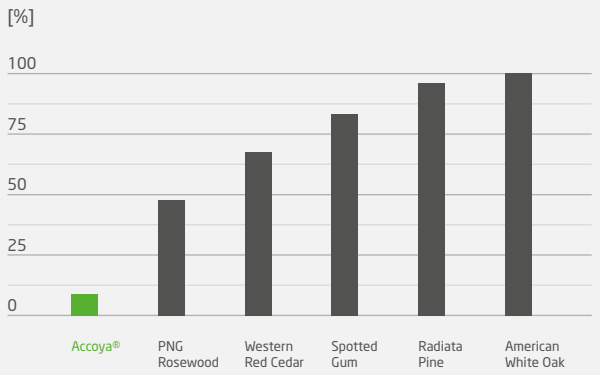
Additional testing run at AFRC in accordance with AWPA protocol include performance evaluation in field testing against Coptotermes acinaciformis and fungal decay testing alongside spotted gum, a durability class 1 rated timber and density of 1,050kg/m³. Accoya® performance matched spotted gum with very low attack in the Coptotermes field trial and bettered spotted gum in the fungal decay testing with almost no attack (<1.0%)







MASS LOSS IN HAZARD CLASS H3 FIELD TRIAL EXPOSURE TO M. DARWINIENSIS



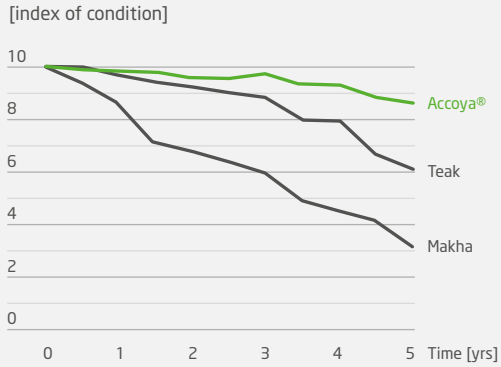
AFRC
Australian Forest Research Company Pty Ltd

TERMITE ATTACK AND DECAY TRIAL, THAILAND

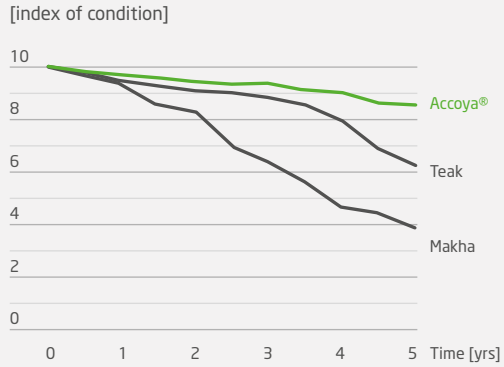
A test conducted by the Environmental Research Centre, Naresuan University involved setting up ground stake tests at sites around Thailand.

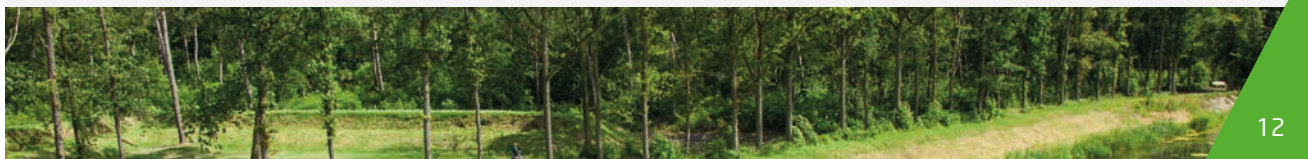
Test stakes were Accoya®, Teak and Makha. After 60 months (5 years) Accoya® is demonstrating significantly higher performance than Makha hardwood and high quality Teak. This superior performance relative to high quality teak corroborates termite and decay evaluation tests reported in earlier pages of this brochure in Florida, Costa Rica and New Zealand

TERMITE RATING



DECAY RATING





15 AND 20 YEAR CANAL LINING TESTS

Accoya® wood's high performance was proven with two Dutch project tests in the Flevopolder near Almere, one installed in 1995 and one in 2000. The SHR institute in the Netherlands originally set up the tests and made detailed inspections at respective 15 and 20 year exposure periods in 2015.

These tests include acetylated wood alongside control wood, preservative treated wood and hardwood species, used as a canal lining (fresh water exposure). 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 (oxygen). Both trials show hardly any sign of rot, decay or fungal damage in acetylated wood – highlighting its class 1 durability status and reinforcing the 25-year warranty. From these test results, SHR concludes that the durability of acetylated wood in fresh water applications competes with highly durable hardwood species and professionally preserved wood.

SHR

STABILITY, DURABILITY & STRENGTH TESTS – TP

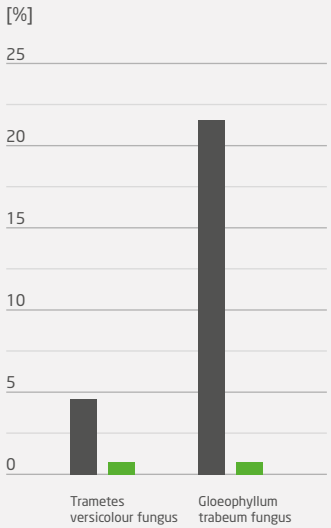
Timber Products Inspection (USA) undertook a number of thorough and independent tests to analyse Accoya® wood's durability, stability and strength performance characteristics in accordance with the USA's Window & Door Manufacturers Association (WDMA) requirements.

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.

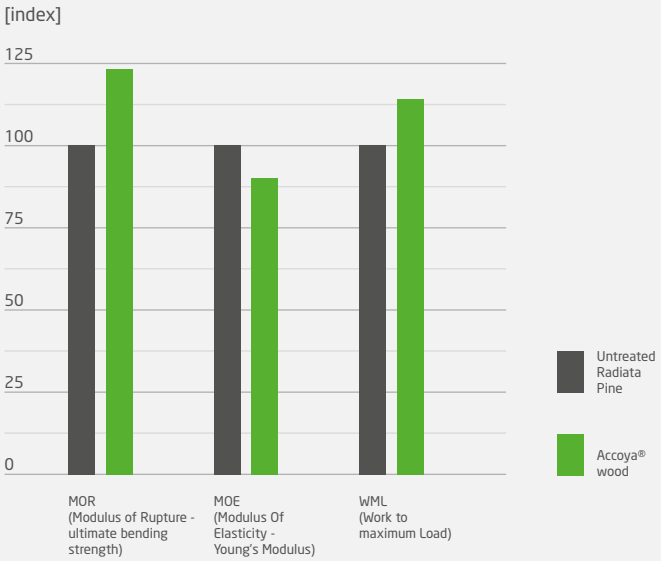
TP also evaluated mechanical properties. Overall, the properties of Accoya® are essentially the same as those of the untreated (radiata pine) control. The MOR and WML values of Accoya® are slightly higher and the average MOE value of Accoya® is slightly lower than that of untreated radiata pine unlike some wood modification techniques that cause significant reductions in strength."

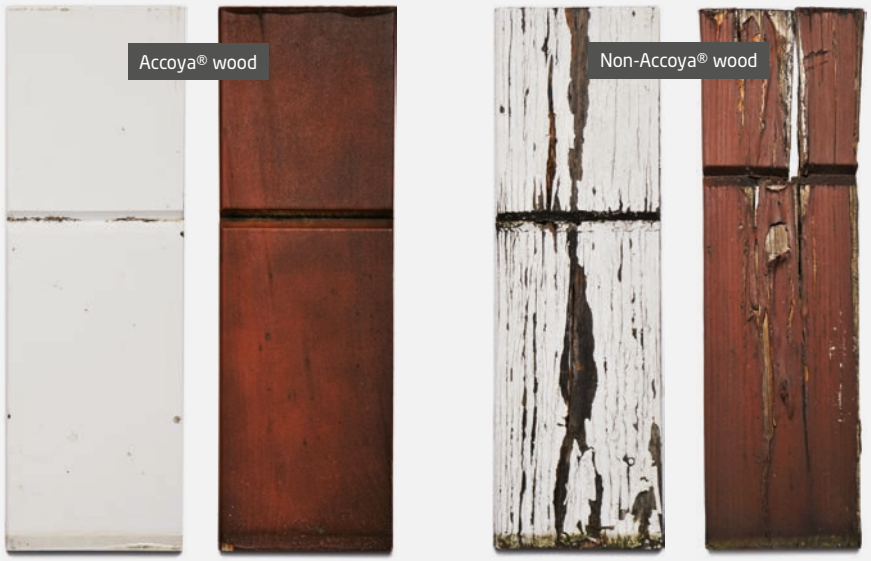
The final test proved that Accoya® meets WDMA's stringent rot resistance requirements, which means it's an ideal choice for windows and doors.

WEIGHT LOSS IN DECAY TEST



TPI CONCLUSIONS



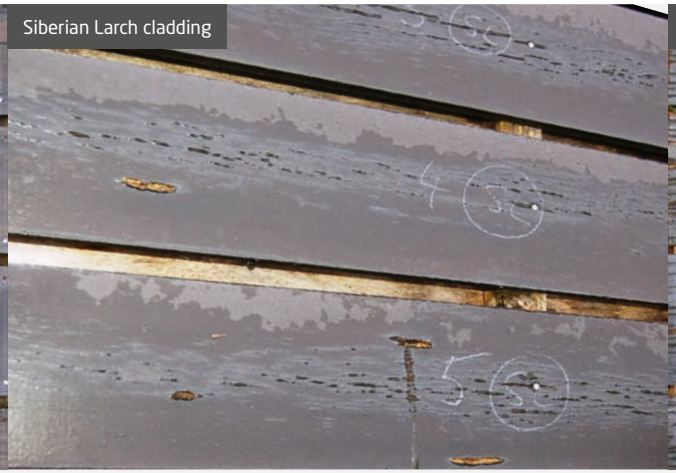


9.5-YEAR EXTERNAL COATINGS TEST – SHR

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


Accoya® wood cladding


Siberian Larch cladding


Pine cladding

3.5-YEAR EXTERNAL COATINGS TEST – BM TRADA

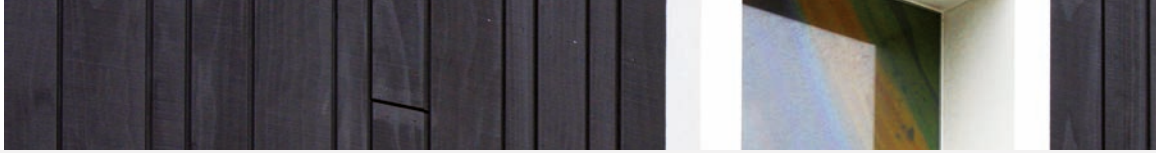
Leading timber research institute, BM Trada, was commissioned by Accsys Technologies to perform a series of exposure trials.

The 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 3.5 years, 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 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 coating issues. This harsh test proves that Accoya® wood has superior coating performance compared to many competing materials. This test, using a translucent black coating for maximum radiant heat build is a particularly difficult situation for wood products. The results have provided the confidence to recommend Accoya® with black coatings around the world, including Australia - with positive real world results.

BMTRADA



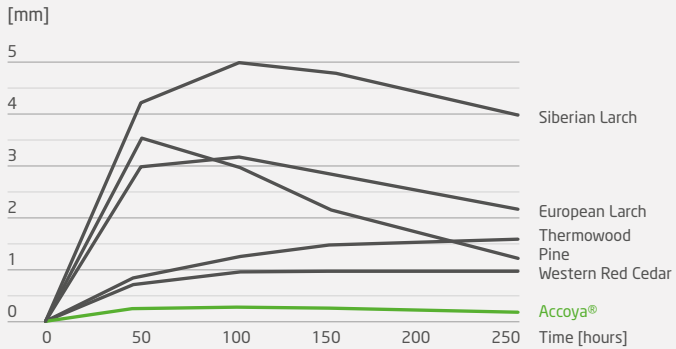
BOARD STABILITY TEST – BM TRADA

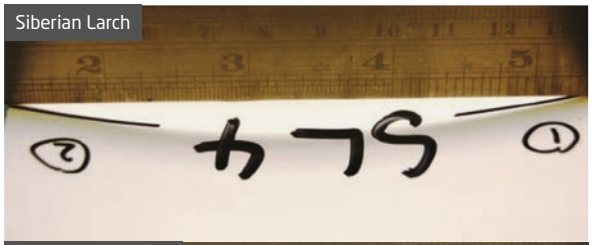
Leading timber research institute, BM Trada, tested the stability of Accoya® wood against other widely used cladding materials by exposing coated boards to a high humidity environment and letting them acclimate.

BM 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.

CUPPING DISTORTION





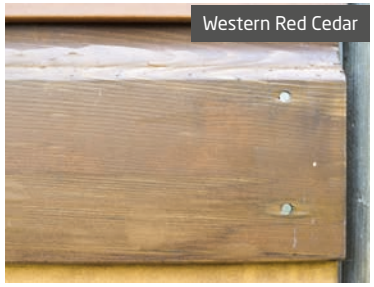
BMTRADA

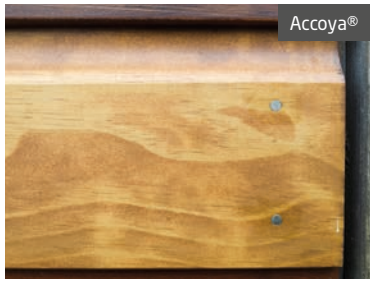
7-YEAR COATING TEST AT TEKNOS – BM TRADA

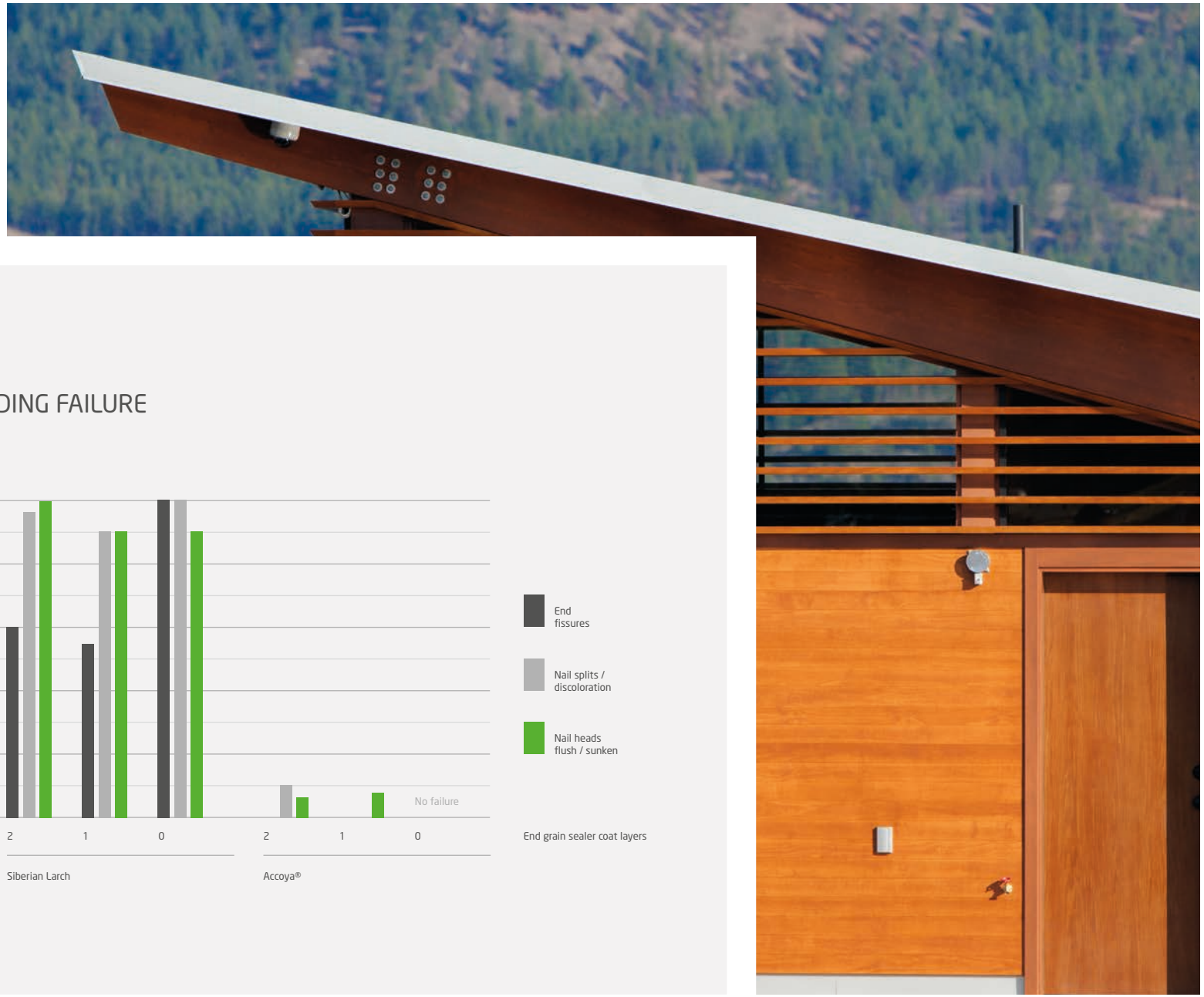
A weathering test was set up by Teknos (UK) Ltd, a leading coating supplied to the factory applied window, door and cladding industry across Europe. The test began in March 2009 to obtain natural weathering performance data, end grain sealing and profile design impact of three different timber substrates (coated) and on different cladding profiles. Apart from Accoya®, Western red cedar (WRC) and Siberian larch were included in the test rig.

After 7 years of natural exposure, the Accoya® boards have exhibited the best performance and have shown excellent stability, which has served to significantly reduce splitting and fissuring at board ends, prevented distortion and fissuring around fixings as well as extending the expected lifetime of the coating.

Coated boards made from Western red cedar and Siberian larch are now in need of immediate maintenance whereas the Accoya® boards are yet to show any significant deleterious effects of weathering after five years and suggests this is likely to be an important factor in the overall reduction of maintenance frequency and costs.







TONGUE-AND-GROVE CLADDING FAILURE

DIMENSIONAL STABILITY TEST – SHR

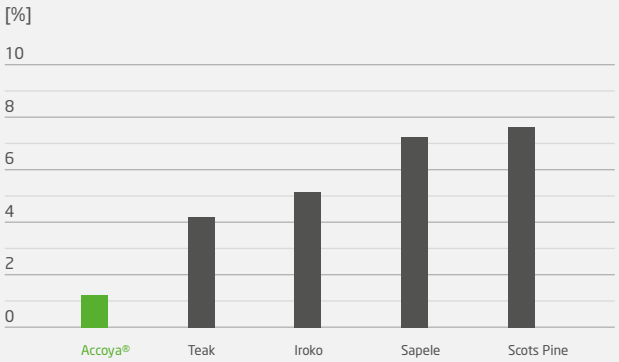
Leading Dutch timber research institute, SHR, undertook a series of tests to evaluate the dimensional stability of Accoya® wood.

Accoya® wood outperformed a wide range of competing timber products such as Teak, Iroko, Sapelle, Scots pine, Western red cedar, Japanese cypress, Japanese cedar and Radiata pine. This significant improvement in dimensional stability of Accoya® over all other timber provides short and long term benefit. In the short term, Accoya® remains stable during processing. In the medium term, joinery remains stable and resists movement when environmental conditions fluctuate after installation. Further on in service, deck boards remain flat, stable around fixings and with practically no splinters. Cladding boards and louvres retain their flush and smooth lines and coated products benefit from the board stability placing less stress on the coating and leading to requiring earlier maintenance.

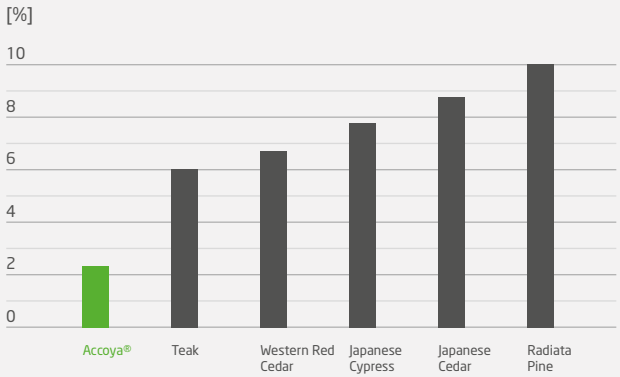
Data on teak, iroko, sapele and scots pine have been extracted from published data:

Physical and related properties of 145 Timbers
Jan F. Rijsdijk and Peter B. Laming
Kluwer Academic Publishers
ISBN 0-7923-2875-2

TANGENTIAL SHRINKAGE



VOLUME SHRINKAGE



IMPROVED THERMAL PERFORMANCE – IFT ROSSENHEIM AND BUILDCHECK

Thermal value is a critical aspect in window and door design. The thermal conductivity of the wood (lambda value) makes a significant contribution to the overall window frame calculated thermal value.

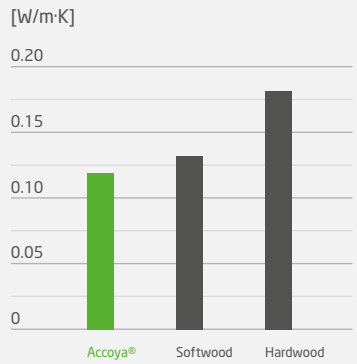
Accoya® thermal conductivity has been assessed by IFT Rossenheim, Germany in accordance with EN1226: 2001 and then developed into the required declared value format, under by the most rigorous European assessment methods by the EN ISO 10456: 2008 procedure for determination of declared and design thermal values.

In comparison to other standard wood types for joinery, Accoya® thermal conductivity is:

- Superior to softwood by 8%
- Superior to hardwood by 30%

These improved levels provide options in design, in terms of achieving a higher U-Value for the same window design by switching timber type, or alternatively using a more preferred aesthetic or production friendly design without significantly compromising energy efficiency.

Accoya® is regularly used to achieve A rated windows under the UKs BFRC Window Energy Rating Program where other woods in the same design would not meet this standard.



THERMAL GAIN ON DECKS, JAPAN

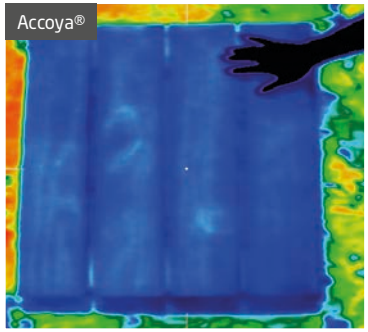
Thermal gain on decks and terraces is a particular issue in the summer season. A thermogram image analysis was arranged in Japan with the Hiroshima Prefectural Technology Research Institute to assess differences between Accoya®, thermally modified wood and three variants of commercial WPC decking.

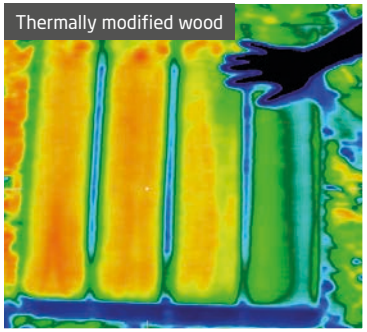
The ambient temperature during the testing of all decks was 32°C. Deck board dimensions were comparable for all three types:

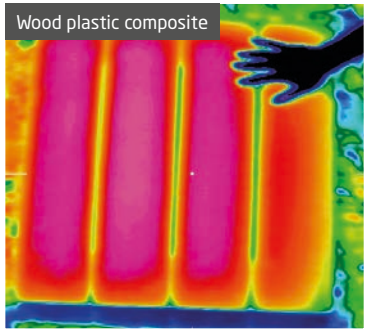
- Accoya®	26 x 140
- Thermally modified wood	26 x 140
- WPC	25 x 145

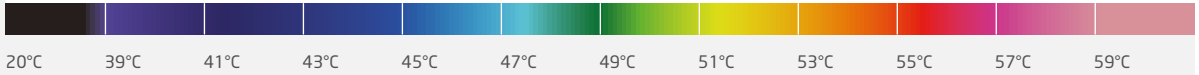
The thermograms clearly indicate thermal gain in Accoya® is substantially less than the alternatives tested.

This low level of thermal gain, combined with in-situ benefits derived from Accoya® dimensional stability provide deck boards which are truly 'barefoot friendly'. In-situ benefits derived from Accoya® stability are the boards resisting cupping and remaining flat, the fixings not being stressed and remaining flush, and finally, the boards not suffering splintering with prolonged weathering.









4 wood types compared for scuff résistance by the Snell Capsule Method at TRADA

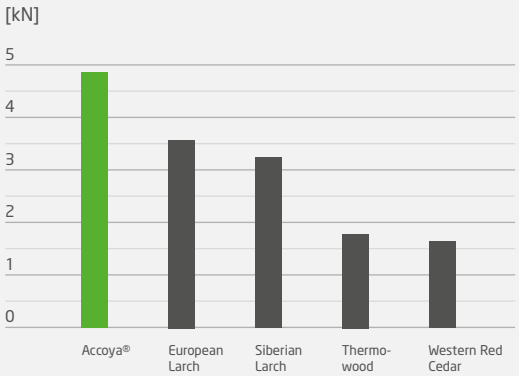
HARDNESS & WEAR TEST – BM TRADA

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

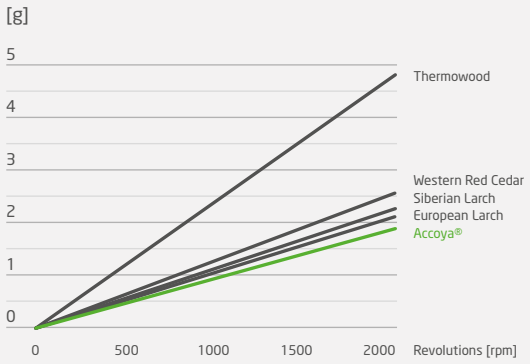
BM Trada's testing showed that hardening that occurs as a result of the Accoya® process results in greater resistance to indentation than western red cedar and two types of larch. This is particularly useful when making specification choices for cladding and ground floor exterior products.

Separate scuffing and mechanical abrasion tests carried out by BM 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.

MEAN HARDNESS LOAD



TABER ABRASION WEIGHT LOSS



BMTRADA

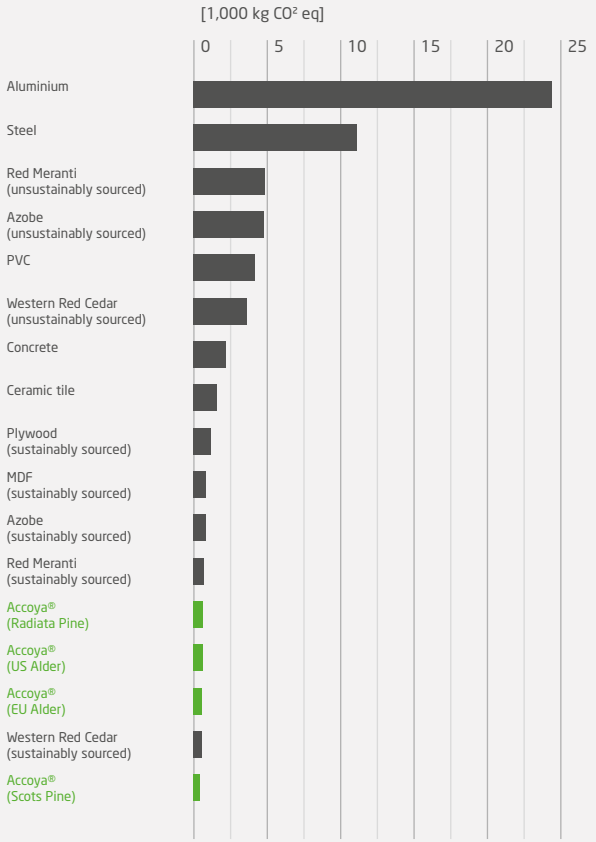
CARBON FOOTPRINTS – VERCO

The environmental performance of Accoya® is thoroughly tested and published following uncompromising leading independent international methodologies such as Life Cycle Analysis (LCA following ISO 14040/44) and Environmental Product Declarations (EPD following EN 15804). The results from these studies are available for download on the Accoya® website and underline the benign environmental performance of Accoya® wood. For example, official carbon footprint studies show that Accoya® wood is an environmentally compatible, even carbon negative, substitute for carbon intensive materials such as plastics, metals and concrete, as well as for various wood species.

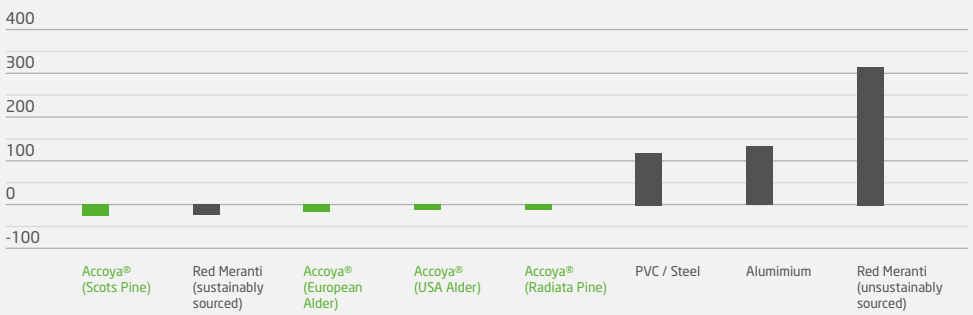
CARBON FOOTPRINT – CRADLE TO GATE

In a carbon footprint assessment, the greenhouse gas emissions (GHG) during the life cycle of a material can be measured, and compared to alternative products in terms of kg CO_2 equivalent (CO_2e). A carbon footprint assessment was executed for Accoya® wood by Verco in line with the World Business Council for Sustainable Development and World Resources Institute's Greenhouse Gas Reporting Protocol best practice guidelines, based on a cradle to gate scenario, thus until the factory gate. This includes sourcing, harvesting and processing of the input timber, as well as all energy and raw material consumption and waste production in the acetylation plant of Accsys Technologies in Arnhem, the Netherlands. The results are shown in the graph to the right.

GREENHOUSE GAS EMISSIONS PER M³ OF MATERIAL



GREENHOUSE GAS EMISSIONS PER WINDOW FRAME (CRADLE TO GRAVE)



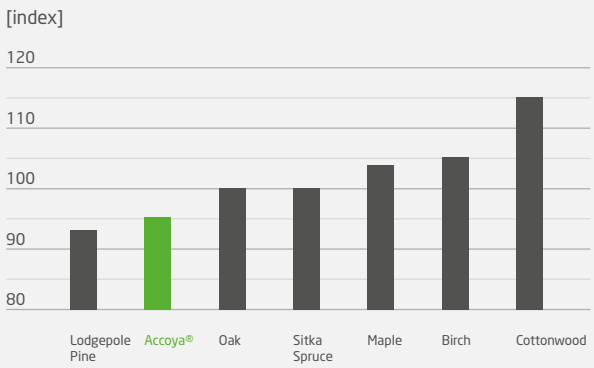
CARBON FOOTPRINT – CRADLE TO GRAVE

The figure above shows the greenhouse gas emissions per m^3 of Accoya® wood from the Verco report, translated into real life application of a window frame by Delft University of Technology, in order to account for the use-phase aspects such as material use, durability, carbon sequestration (following PAS 2050 guidelines), maintenance and recycling scenarios.

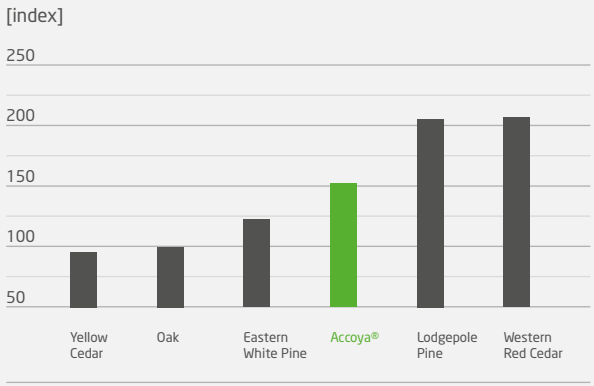
The results show that Accoya® scores significantly better than metals (aluminium), plastics (PVC), and unsustainably sourced hardwood and is on par with sustainably sourced (certified) hardwood. In case locally sourced wood is used to produce Accoya, it is the best choice from environmental point of view, not yet including the better performance characteristics such as the improved dimensional stability and UV resistance. Interestingly, because of the limited emissions during production, carbon credits that can be 'earned' through i) temporary carbon storage during use (especially in case of a long lifespan) and ii) incineration for electricity in the End of Life phase, all sustainably sourced wood alternatives, including Accoya, are CO_2 negative over the full life cycle.

It should be noted that the annual yield of renewable materials is not included in the carbon footprint, which provides an important additional environmental advantage to wood, and in particular for Accoya based on Radiata Pine, over non renewable materials. For example, the availability of sustainably sourced Meranti is limited, which makes illegal sourcing – with its catastrophical consequences – of this slow growing hardwood species from tropical forests a reality which often occurs.

FIRE SPREAD INDEX*



SMOKE DEVELOPED INDEX*



* data source: USDA (United States Dept of Agriculture) Wood Handbook.
Lower numbers equal less flame spread or smoke.

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 (ASTM E84, 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.

Flame Spread Classification	Flame Spread Index
Class I (or A)	0 - 25
Class II (or B)	26 - 75
Class III (or C)	76 - 200

Please see Accoya® Wood Information Guide for European classification D in EN14915.

IMPROVING PERFORMANCE, REDUCING ENVIRONMENTAL IMPACT

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

ACCOYA®
ACCREDITATIONS

C2C

Accoya® wood is one of the very few building products to have acquired Cradle to CradleSM Certification on the elusive C2C Gold Level, and for the category Material Health even at Platinum level, the highest possible!. Cradle to Cradle provides a means to tangibly and credibly measure achievement in environmentally-intelligent design including the use of environmentally safe and healthy materials and instituting strategies for social responsibility. As a result, specification of Accoya® also yields additional credits in LEED v4, BREEAM and Google's Healthy Materials Portal, Portico.

FSC®

Of the various schemes for sustainability forestry available, the Forest Stewardship Councils (FSC®) is regarded as the leading and most comprehensive certification programs available.

AIA & RIBA

Contact us to arrange an Architectural Institute Accredited CPD or CEU presentation.

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