PATHWAYS TO BUILDING CODE COMPLIANCE FOR FARM-TOTARA TIMBER

Tāne's Tree Trust Project Report

June 2016 (Revised July 2021)

Dean Satchell

PATHWAYS TO BUILDING CODE COMPLIANCE FOR FARM-TOTARA TIMBER

June 2016

Dean Satchell
Sustainable Forest Solutions
dsatch@gmail.com
www.go-eco.co.nz

A report prepared on behalf of the Northland Totara Working Group.

This project was funded by the Ministry of Primary Industries Sustainable Farming Fund (Project No. 408099), and co-funded by Tāne's Tree Trust and the New Zealand Farm-forestry Association (including a contribution from the Indigenous Forestry Section).

Ministry for Primary Industries
Manatū Ahu Matua

Tāne's Tree Trust
Native Trees for the Future

New Zealand Farm Forestry Association

Table of Contents

Executive Summary

Potential markets for farm-totara timber would be significantly improved by complying with New Zealand's performance-based Building Code. A range of potential products and applications hold the promise of market demand but these are not currently given consideration because they are not code-compliant.

The path to compliance would ideally be one leading to 'Acceptable Solutions' in terms of the Building Code. This would require research and testing, especially into levels of durability that would first provide suitable evidence to comply under what is termed 'Alternative Solutions', followed by advocating for changes to compliance documents, especially NZS 3602, so farm-totara would comply as Acceptable Solutions.

Products that should be tested for code-compliant durability performance include structural timber, exterior cladding, exterior joinery and decking. Durability performance of structural elements should be compared to H1.2 treated radiata pine and untreated Douglas fir. Exterior cladding and decking should be both tested in service for evidence of meeting the 15 year durability performance required in NZS 3602, along with accelerated decay testing to compare natural durability of farm-totara with H3.1 radiata for cladding and H3.2 radiata for decking.

Industry collaboration with Scion should continue, including undertaking wet-framing tests, boron impregnation and diffusion tests, and heartwood characterisation. Results of durability performance testing would take some time, but lead to the improved understanding required for code-compliance.

NZS 3602 is expected to be reviewed during 2016 or 2017 and the New Zealand Farm Forestry Association (NZFFA) are expected to have representation on the Standards Committee. The representative could advocate for a revised standard that is more inclusive of farm-totara, especially for non-structural interior finishing timber and flooring. Longer-term, evidence of durability performance could lead to future revisions that include farm-totara as an Acceptable Solution for structural applications, cladding, exterior joinery etc., depending on the outcomes of the testing.

Paths, required tests and actions to achieve compliance of farm-totara timber with the New Zealand Building Code, are set out in the recommendations of this report.

Establishing Building Code compliance, for farm-totara timber, is likely to have an immediate and significant impact on the market demand and greatly increase the potential value of the resource to land-owners. It is also an essential part of the process to facilitate development of a new forest industry, one based on the sustainable management of totara forests on private land in many regions around New Zealand.

Introduction

Totara is a prominent feature of the rural Northland pastoral landscape, typically regenerating on erosion-prone pastoral hill country and favouring lower-quality pastures. Because it is relatively unpalatable to grazing stock, 'farm-totara' regenerates so prolifically that many pastoral landowners have regarded it as a weed. However, over the last century or more substantial areas of dense second-growth totara-dominated stands have developed with the potential to be managed as a sustainable resource, complementing the existing pastoral farming land use.

Potential exists to develop a significant regional industry in Northland based on the use of timber from regenerating (and planted) totara on private land – 'farm-totara'[1]. Encouraging sustainable management of the resource would bring multiple benefits to the region and provide a vehicle to realise ecological, environmental, cultural, social and economic benefits. This has been the vision of the Northland Totara Working Group. Since it was formed in 2005, the group has successfully conducted many projects to progress this initiative.

Presently, the primary focus is on developing the opportunity in the Northland region. However, this opportunity could extend to private land, including Maori land, and in many other regions around the New Zealand.

Under the umbrella of Tāne's Tree Trust the NTWG is represented by a wide range of stakeholders in Northland including the New Zealand Landcare Trust, landowners, New Zealand Farm Forestry Association, the District and Regional councils in Northland, wood millers and processors, and representatives of the Ministry for Primary Industries.

The major objectives of the NTWG include:

- identifying gaps and supporting research into determining wood properties and potential uses of farm-grown totara;
- investigating the feasibility of developing a supply chain from resource to market; and
- identifying and overcoming impediments to the sustainable management of naturally-regenerating and plantation totara.

This project is part of that wider and ongoing initiative.

Totara is an iconic native timber tree species in New Zealand. However, traditional use and knowledge is based on timber from 'old-growth forests', i.e. trees that were often many hundreds of years old. Timber from regrowth or farm trees, known as "farm-totara", has been confirmed as a high quality native timber with strong market interest[3]. Farm-totara has lower levels of heartwood than old-growth totara traditionally harvested in New Zealand and used for applications requiring high levels of durability. Little is currently understood about durability performance of farm-totara for applications that are required to comply with the Building Code such as cladding and structural elements. This uncertainty has been identified as a major impediment for landowners wishing to manage, market and utilise the resource.

There are a range of approaches which may achieve code-compliance, including durability and preservative treatment tests that lead to amended compliance documents. However, the steps are to firstly investigate and analyse the current situation, then set out recommendations for practical pathways to achieve optimal Building Code compliance for farm-grown totara timber products that lead to market development opportunities.

Applications requiring Building Code compliance such as cladding, joinery (exterior and interior), flooring and panelling (interior linings) are investigated. Structural applications are also considered. Although structural timber markets tend to generally be low value and commodity-based, there may be high-value opportunities for decorative structural applications that use higher grades of appearance timber, such as in rafters, beams and laminated members.

This has been a grower/industry-led investigation to ensure that future work and efforts are well targeted for maximum benefit and relevance in terms of commercialising farm-totara as a sustainable economic resource. This involves timber from naturally regenerated 'second-growth' trees on private land[2]. Therefore, recommendations in this report are tailored for relevance to timber from what is being termed the farm-totara resource.

References

1. *Tai Tokerau Northland Growth Study*. Opportunities Report February 2015. Martin Jenkins. Ministry for Primary Industries, 2015. (Pages; 50, 51)
2. Bergin, D.O. 2003: Totara establishment, growth and management. New Zealand Indigenous Tree Bulletin No. 1. New Zealand Forest Research Institute. 40p.
3. Quinlan, P. 2011: Existing uses and market development opportunities for naturally regeneration totara timber. SFF Project L10/145. Report for the Northland Totara Working Group. 98p.

1. Totara and issues of Building Code compliance

The Building Code contains compulsory rules for all new building work and sets out performance criteria that building work must meet.

The Building Code does not prescribe how work should be done, but states how completed building work and its parts must perform. An advantage of a performance-based Building Code is flexibility - it contains no prescriptive requirements stipulating that certain products or designs must be used. This flexibility offers opportunities for developments and innovation in building design, technology and systems[8]. However, demonstration of adequate performance of building materials in specific applications is required, either by providing evidence of compliance (such as durability performance), or by using Standards that offer code-compliant materials or methods.

Compliance with the Building Code can be demonstrated using various pathways. Some pathways ***must be accepted*** by the building consent authority as meeting the performance requirements of the Building Code[8]. Compliance paths such as Acceptable Solutions are desirable because designers are likely to specify materials that comply with Acceptable Solutions. Thus ready markets exist due to the ease with which consent is granted.

Chemical treatment

Options for chemical treatment of farm-totara to Hazard Classes greater than H1.2 (such CCA pressure treatment, LOSP etc.) are not considered in detail in this report, noting that NZS 3640:2003 *Chemical Preservation of Round and Sawn Timber* specifies that Hazard Classes H2, H3.1, H3.2, H4, H5 and H6 apply only to *Pinus* species. Heart totara is well known to be resistant to the uptake of CCA treatment, but the sapwood, although moderately resistant can be successfully treated. Anecdotal evidence indicates that LOSP has also been successfully applied with good durability for external applications. Chemical treatment may therefore, provide a ‘fall-back’ contingency option for building code compliance where Hazard Classes greater than 1.2 are required. However, the industry views such chemical treatment as a highly undesirable pathway, one that would likely create a disincentive for the use of farm-totara timber. Boron treatment, however, has been investigated and is discussed within this report.

Compliance with the Building Code, for specific uses, based on the natural characteristics and constraints (particularly durability) of the farm-totara timber resource has been the focus of this investigation.

Structural Durability

Timber, being a natural material, is variable in durability performance depending on species, application and conditions it is exposed to in service.

"Leaky buildings"

Leaky buildings are described as those that both allow water to penetrate the building envelope or cladding system and that then hold the water in the wall cavity, where it may remain for some time. This results in the building's timber framing staying wet, raising its moisture content to levels that then allow fungal growth. It should be stressed that although the Building Code requires framing timber to be durable for 50 years, any timber, regardless of the standard to which it is treated (including the H3 standard) will decay if it remains wet (Parliament 2002).

The Building Code

Although the Building Code now requires structural timber to be treated to a minimum of H1.2 boron (0.4% BAE), the exception allows untreated Douglas fir to be used where the building is a traditional low risk house (Clause 3.2.2.2 B2/AS1). Justification for this exception was based on research showing that untreated douglas fir sapwood was more durable than radiata pine sapwood.

The required level of durability (in years) under situations of moisture ingress does not appear to have ever been defined for such low risk houses, and thus the only option available for Alternative Solutions that involve different species to Douglas fir is to compare and test levels of durability against Douglas fir.

Research Results

Research undertaken by Scion on decay resistance of framing in situations where moisture content is raised, showed that sapwood of cypress species had higher durability than sapwood of Douglas fir[1]. Larch sapwood was of equivalent durability to Douglas fir sapwood and heartwood of both larch and Douglas fir was also of equivalent durability. However, NZS 3602 *Timber and wood based products for buildings*, has not been updated to reflect the results of this research, nor has Clause B2/AS1 of the Building Code. Farm-totara was not tested.

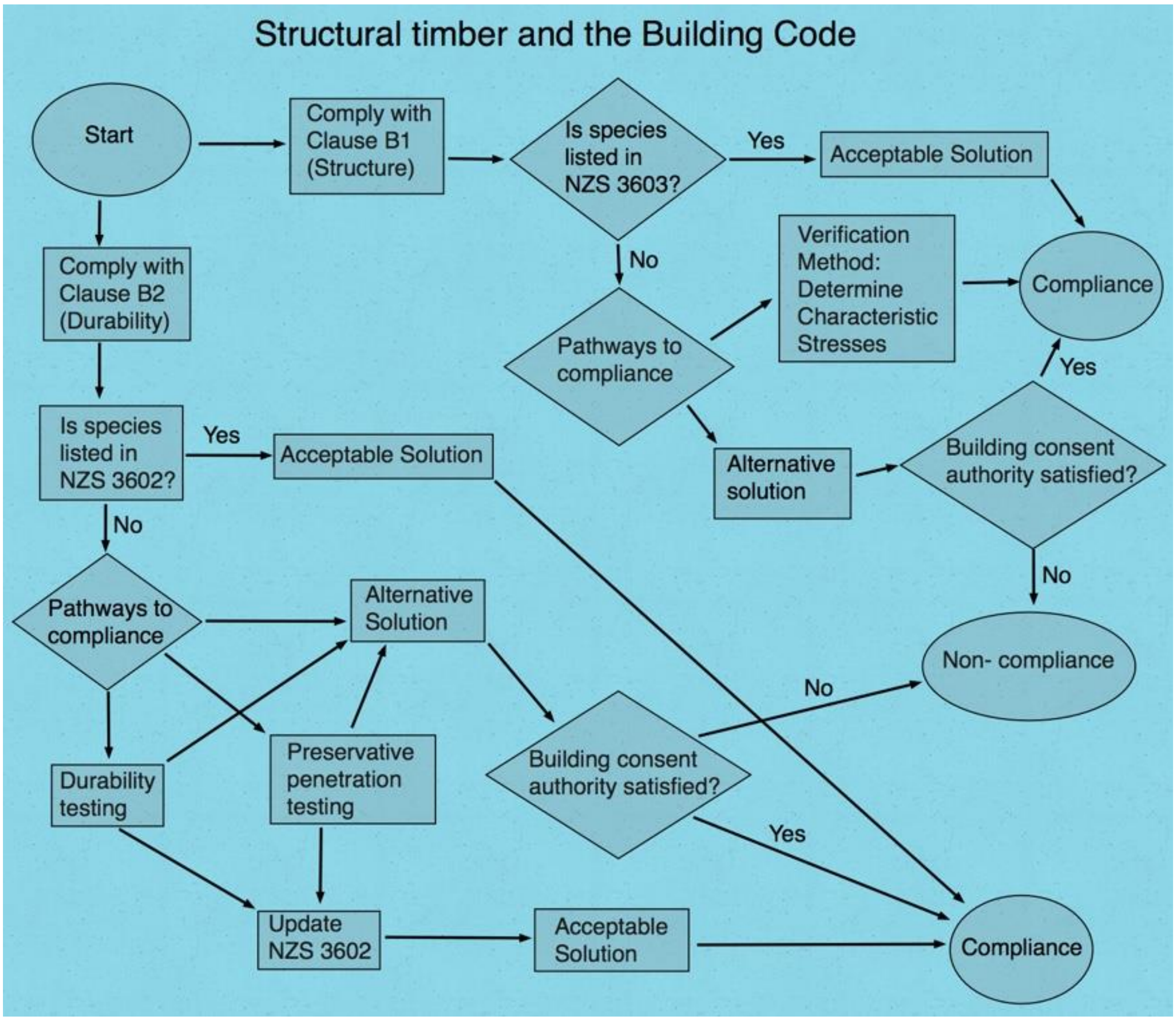
To meet the durability performance requirements of the building code, testing would at least need to demonstrate equivalent or better durability than untreated Douglas fir. If totara sapwood were tested to have equivalent or better durability than Douglas fir sapwood, then either NZS 3602 or B2/AS1 3.2.2.2 could be updated to include totara as complying with the durability requirements of the Building Code as an Acceptable Solution for structural timber not requiring treatment in houses of low risk design. If farm-totara were shown to have equivalent durability to H1.2 treated radiata pine, NZS 3602 could also be updated to allow farm-totara to be used as an acceptable solution in all applications requiring H1.2 treated radiata, as complying with the durability performance requirements of the Building Code.

However, at present, the appearance characteristics of farm-totara timber in respect to differentiating sapwood from heartwood and the possible existence of a transitional zone of 'intermediate wood', are not well understood nor comparative natural durability quantified. This also needs to take place in order to confirm that visual grading based on colour is possible for building-code compliance under some applications.

As an interim measure prior to inclusion in NZS 3602, testing of durability performance as framing with raised moisture content would offer evidence suitable for alternative solutions. Although building consent authorities allow alternative solutions at their discretion, compelling evidence of equivalent durability to either untreated Douglas fir or H1.2 treated radiata would allow the important first steps in market development to take place, with industry-supported education (e.g. via the Northland Totara Working Group or Farm Forestry Timbers) leading to acceptance as a building material the likely outcome.

Compliance Paths

The following flow chart outlines the compliance paths for timber under the Building Code. Totara complies with B1 (Structure) because characteristic stresses have been determined for the species. However, because totara is not listed in NZS 3602, the only compliance path currently available for B2 (Durability) is via an Alternative Solution.



The flow diagram above illustrates that each building consent authority would need to be satisfied that farm-totara complies with the Building Code as an alternative solution under Clause B2 Durability. For a generic alternative solution to be prepared for structural applications using farm-totara, technical information would be required demonstrating compliance.

Verification Methods for durability

The durability clause (B2) in the NZ Building Code contains specific default minimum service lives for buildings and their components. Structural elements, including structural fixings and bracing materials, have a 50-year service life requirement.

The minimum requirement for a H1.2 treatment for timber framing is to provide protection in-service. However, H1.2 preservative treatment is not designed for extended exposure to elevated moisture content[3].

NZBC B2 VM1 provides some guidance for proving durability performance, but this is limited in scope. For example there is no Verification Method for proving durability performance of structural timber, because the expected in-service exposure conditions, if taking into account the possibility of moisture ingress and entrapment, would not meet the expected service life of 50 years under the H1.2 Hazard Class. Test methods or in-service history would require a defined threshold of time to decay where exposed to moisture content conducive to decay. Such test methods should be standardised for both treated and untreated timber.

A Verification Method for durability performance based on time to decay would provide a "level playing field" for testing chemical treatment, modification methods and natural durability (for example structural elements potentially subject to moisture entrapment) against a benchmark durability threshold as time before decay.

Acceptable Solutions for durability

NZS 3640:2003 *Chemical preservation of round and sawn timber* sets out requirements for the preservative treatment and identification of timber to provide protection from decay and insect attack, based on six hazard classes that are described in the Standard.

NZS 3640 clause 1.2 states that:

> The requirements for hazard class H1.1 and H1.2 apply to all species for which hazard class H1.1 and H1.2 is specified in NZS 3602. Hazard classes H2, H3.1, H3.2, H4, H5 and H6 ***apply only to Pinus species***[4].
>
> While it may be possible to treat other species using the provisions of this Standard, such treatments are outside the scope of this Standard and the adequacy of the resulting treatments will need to be demonstrated[5].

It is not clear how building consent authorities would view "demonstration" of "adequacy" to remain an Acceptable Solution, or whether they would view such demonstration as an Alternative solution.

NZS 3602 does not include totara as an Acceptable Solution for any application, including structural, cladding, decking and door/window joinery. Review of standards offers an opportunity to provide evidence supporting inclusion.

It should be noted that for structural applications, sapwood of all species included in NZS 3602 must be treated to H1.2. Natural durability is not yet well understood for farm-totara in different applications, especially the impact radial position of wood in the log has on natural durability.

Fire regulations

Changes made in 2012 to the Building Code provisions for fire safety resulted in a MBIE review initiated in 2014 and a plan to improve fire safety in New Zealand[6]. The resulting Fire Programme was made up of 14 projects, including assessment of timber linings in buildings.

Under the current Building Code provisions, wood products are allowed to be used without restriction as[7]:

- wall or ceiling linings in detached homes or within individual apartment units
- timber joinery, or general decorative trim

- structural timber elements (beams, columns or walls) except that individual structural shear walls may not be more than 3.0 m long.

  Note: Small non-conforming areas of up to 5.0 m^2 are permitted

Commercial buildings such as offices, factories, shops, schools, restaurants etc have restrictions on the use of timber.

As a general rule, walls and ceilings in buildings such as offices and small factories (other than crowd or sleeping occupancies) can use most uncoated, paint-coated or clear coated timber with no need for testing, provided that the wood is[7]:

- at least 9mm thick
- at least 400kg/m^3 density for solid wood.

  Note: there are restrictions on coating types and density[7].

Because farm-totara has a market niche as an appearance grade timber, market limitations currently exist for use as appearance linings in some commercial buildings. Such limitations are not likely to excessively constrain market development initiatives for the timber, however.

References

1. Summary of Tests on Untreated Douglas-fir, Treated and Untreated Radiata pine for Use as Framing in Domestic Construction in New Zealand. *Future Forests Research New Zealand*, report No. FFR-DS029
2. NZ Building Code clause B2 Durability
3. New Zealand Building Code Clause B2 3.1.1
4. NZS 3640:2003 clause 1.1.2
5. NZS 3640:2003 clause C1.1.2
6. Fire Programme, Ministry for Business and Innovation
7. Use of timber under NZ Building code fire regulations, A. Buchanan & J. Parker, 2014
8. New Zealand Building Code Handbook (2014)

2. Potential end uses of totara timber

The New Zealand Building Code provides challenges for those applications where timber is required to comply with durability or structural requirements. Such applications include cladding, decking and structural. For markets to develop with sufficient volumes that support an industry, farm-totara would need to overcome compliance issues for structural applications. There are clear market opportunities for higher grades as appearance exposed structural elements and for lower grades as structural lumber, provided appropriate testing is undertaken that provides Building Consent Authorities and consumers assurance of suitability for purpose.

Crosslam

Cross Laminated Timber (CLT), sometimes referred to as crosslam, is a relatively recent engineered product introduction into the New Zealand market. Panels are produced from sawn timber boards glued in layers. Construction using CLT needs to meet the structural requirements of the Building Code, and thus a 50 year life. Durability performance under clause B2 of the Building Code requires a minimum of H1.2 boron treatment. The exception for untreated Douglas fir for use in buildings of low-risk design might offer an opportunity for use of untreated timber CLT but before considering the opportunity for farm-totara, demonstration of untreated Douglas fir in service as CLT should take place and confidence in that product evident.

One manufacturer has identified this opportunity to produce code-compliant untreated CLT from Douglas fir *. For farm-totara to hold this same opportunity evidence is required that durability performance is at least equivalent to Douglas fir. Frame-tests would provide the evidence to support inclusion, which would need to be followed up by participation in relevant standards committees advocating for a level playing field.

There may be opportunities for use of farm-totara in CLT applications as a decorative interior face in panels.

LVL

Laminated Veneer Lumber (LVL) is not produced as a decorative product and farm-totara does not offer improved strength or stiffness over radiata pine*. Therefore, this product is not recommended for pursuing as a market opportunity for farm-totara.

Structural solid timber

Opportunities for developing markets for structural solid timber applications abound for farm-totara.

Framing

Lower grades of wood (e.g. FFT No. 2 framing grade) are a by-product from selecting more valuable appearance grades and generally require a market for profitable production of higher grades. If H1.2 treatment and structural verification of visual grades were not necessary, producers might be able to market timber at the "farm gate" thus avoiding overheads and potentially producing commercially competitive farm-totara products. The strength properties of farm-totara suggest that verification would not be necessary for FFT visually-graded FFT No. 1 Structural grade SG6 as either an Alternative Solution or for inclusion in NZS3603 and NZS3604 as an Acceptable Solution. Another opportunity for lower grades is to cut short clear lengths and finger-joint these into lengths suitable for appearance glulam.

Appearance structural

Appearance structural applications are essentially an untapped market in New Zealand because of building code constraints that limit compliance to Acceptable Solutions. In the case of totara, by not being included in NZS 3602, durability performance is not established for an Acceptable Solution, with the only option an Alternative Solution which is perceived to be costly and inhibitive by specifiers and designers. Suitable applications for farm-totara include solid-timber exposed beams and rafters, along with appearance glulam.

Glulam

In New Zealand Structural glulam is primarily produced from radiata pine and Douglas fir, because the Building Code offers compliance for these species as Acceptable Solutions. Other species can be used by following the Alternative Solutions path. However, architects and specifiers may avoid timber species that are perceived to be difficult to achieve compliance, thus Alternative Solutions are viewed as a barrier to the market. Because Farm Forestry Timbers have determined the Characteristic Stresses for farm-totara, the primary constraint to its use as glulam is meeting the requirements for Hazard Class H1.2 (0.4% mass/mass boric acid equivalent) by determining appropriate methods for boron infusion into sawn timber.

Pathways to compliance for structural applications

Two pathways offer alternatives for achieving building code compliance:

1. For buildings of simple design, producing evidence of similar or greater durability than untreated Douglas fir would be suitable for Alternative Solutions. Untreated farm-totara could be tested as wet framing against Douglas fir by an accredited and appropriate wood testing entity (e.g. Scion). If evidence were produced that farm-totara was of similar or greater durability than Douglas fir under this test, and evidence that insect (borer) attack is not an issue with farm-totara, inclusion in NZS 3602 as an Acceptable solution under the same requirements for untreated Douglas fir could be pursued.

2. For standard structural applications evidence of 0.4% mass/mass boric acid equivalent infusion as per NZS 3640 for H1.2 would be required for either an Alternative Solution or inclusion into NZS 3602 as an Acceptable Solution.

Window joinery

Traditionally, heart totara from old-growth forests, was a favoured timber for window joinery. Its dimensional stability and Class 1 durability level made it unquestionably suitable for such demanding applications. In respect to the new farm-totara timber resource, there is a lack of quantitative information on its relative durability and performance. Because differentiating and segregating heartwood from intermediate and sapwood may not be practicable in sawn timber, durability performance falls on the lowest denominator (sapwood) and attaining a durability performance of at least 15 years as required by NZS 3602 may not be consistently achievable. Research could explore coatings, treatments or moisture barriers and demonstrate adequate durability performance of farm-totara external joinery. If evidence were produced of adequate durability, this could be used for Alternative solutions and eventually lead to updating NZS 3602 as an Acceptable Solution.

Thermal modification offers both an improvement in durability but also greater dimensional stability. Research into stability of thermally modified farm-totara for window joinery could open market opportunities for higher grades as high-value decorative wooden window and door joinery if superior to thermally modified radiata pine.

External joinery was a traditional use and market for totara timber, until substituted with aluminium. However, now double-glazing and profiling for better water channelling, requires more material bulk than was previously used. The increased material costs may help make a suitable timber option more competitive.

Compliance with the Building Code also requires testing of window and door joinery for the wind zone and labelling according to NZS 4211.

JMF NZ offer solutions for NZS 4211 compliant timber joinery. NZS 4211 deals with weathertightness in wind zones and registered master joiners can become affiliated with JMF to use the available styles of compliant joinery and have access to the specifications. Because the timber species used for testing the JMF styles of joinery was imported cedar, provided the timber used was of similar or greater strength than cedar, compliance with NZS 4211 would not be an issue. Farm-totara timber is denser and stronger than cedar based on characteristic strength tests undertaken by NZFFA.

However, compliance with NZS 3602 (durability) is an issue because only heartwood for redwood, Western red cedar and cypress is listed in NZS 3602 Table 2 (2A.5, 2A.6) as Acceptable Solutions. If farm-totara were to be tested and demonstrated to have 15 years durability performance as exterior joinery an alternative solution could be prepared, leading to inclusion within NZS 3602.

Weatherboards and cladding

Durability performance of at least 15 years is required by the NZ Building Code for exterior cladding. In-service evidence would need to be established demonstrating greater than 15 years durability as cladding for sapwood. Limiting cladding to heartwood is complicated with farm-totara because of issues with differentiation based on colour and the unknown durability levels of any younger 'intermediate' heartwood zone. If evidence of sufficient durability were established, Alternative Solutions would offer the only option for utilising farm-totara as cladding, until *NZS 3602 Timber and wood-based products for use in building* were to be updated to include farm-totara as an Acceptable Solution for cladding.

Decking and external stairs

Durability performance of at least 15 years is required by the NZ Building Code for external decking. Evidence of this being achieved by farm-totara would be required to justify inclusion in *NZS 3602 Timber and wood-based products for use in building*. Farm-totara sapwood is not likely to hold durability sufficient for this application and grading for durability based on more colour does not yet have sufficient evidence of relative durability performance.

Thermal modification might hold some promise of sufficient durability for decking, however research would need to demonstrate both sufficient strength and durability for this application.

Flooring

The specified durability level requirement in NZS 3602 for interior flooring timber is 50 years. Totara is not included in table 1 *1C.3 Interior flooring, suspended ground floors* in *NZS 3602 Timber and wood-based products for use in building.* This appears to be an oversight and advocating for its inclusion in the next revision of NZS 3602 is required. This would then allow farm-totara to be used as flooring under an Acceptable Solution. Until included farm-totara flooring is an Alternative Solution.

Non-structural interior timber

Farm-totara timber is not listed in NZS 3602 as an Acceptable Solution for interior finishing timbers. The requirement is for a 5 year durability performance and advocacy should take place to have farm-totara included in Table 3 – Requirements for wood-based building components to achieve a 5-year durability performance.

---

3. Progress towards compliance for farm-totara

This section looks at measures currently being taken and further measures that will be required to provide evidence for updating the building code.

Durability and Hazard Classes

H 1.2 boron treatment has become the de-facto "durability benchmark" for structural applications because the Building Code requires radiata pine to be treated to 0.4% mass/mass boric acid equivalent. Sapwood of all species listed in NZS 3602 is required to be treated to H1.2 for internal structural applications to average cross-section concentrations of 0.4% mass/mass boric acid equivalent (BAE). Producers of H1.2 timber are required to verify the level of treatment but little is known about treatment methods that would achieve adequate cross section concentrations of preservative.

Boron penetration testing

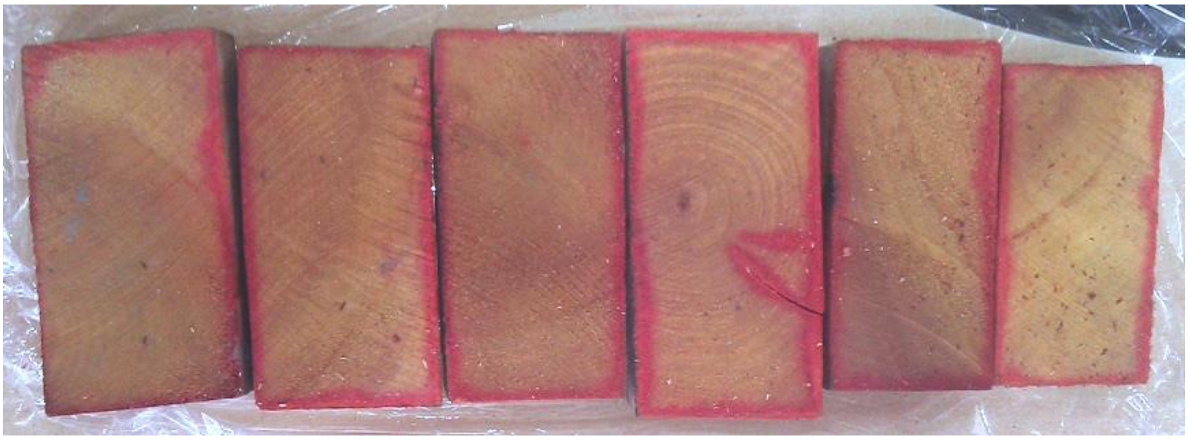
In order to assess the ability of farm-totara to be adequately penetrated by boron to the H 1.2 specification, samples were placed in two charges of radiata pine and put through the standard treatment process at North Sawn Lumber, based at Ruakaka Northland, in February 2016. North Sawn Lumber use a fluctuating hydraulic pressure treatment process they call the "Rouping cycle". This process allows rapid treatment and throughput of timber. Dry radiata pine of 20% or less moisture content is treated, with moisture content after treatment to be not be more than 26%.

Ends of all samples were painted with acrylic paint after being halved, one half of which went to each of the two standard treatment settings used for radiata pine.

The farm-totara timber samples were air-dry rough-sawn 100 x 50 farm-totara comprising mostly sapwood, but some boards had intermediate heart present.

Testing of boron penetration is routine and part of the auditing and compliance process undertaken by North Sawn Lumber. Cross-section biscuits were tested at North Sawn Lumber using a tumeric (curcumin) reagent with a salicylic acid buffer for assessing boron penetration into the samples.

Farm-totara treatment 1: 1st set point 18kPa (20 secs), 2nd set point 65 kPa (70 secs), final vacuum -85 kPa (6 mins)



Farm-totara treatment 2: 1st set point 18 kPa (20 sec), 2nd set point 55 kPa (65 secs), final vacuum -85kPa (6 mins)

Example of Radiata pine 90x45 framing: 1st set point 18kPa (20 secs), 2nd set point 55 kPa (65 secs), final vacuum -85 kPa (6 mins)

Many thanks to Garth Mortensen of North Sawn Lumber for undertaking the testing.

Most radiata samples are expected to have full penetration of boron using this treatment process, whereas no farm-totara samples had adequate penetration of boron. This suggests that standard practice pressure treatment methods for dry radiata pine may not be appropriate for farm-totara.

Boron diffusion

Traditionally boron was applied to green sawn timber under a dip-diffusion process followed by block stacking to aid diffusion. The treatment was allowed to diffuse for sufficient time until full penetration of sapwood occurred (usually between two and eight weeks) before drying the timber.

Boron diffusion is no longer practiced commercially for radiata pine, primarily because modern practices offer rapid throughput from log to product. The cost of diffusing and block-stacking for 6 weeks under cover, before air drying under cover for another 6 months or more is out of the question for lower-value commodity timber but should be investigated to evaluate the practicality and economics of producing H1.2 farm-totara.

Another issue is the additional constraint of auditing retention of boron to satisfy regulatory requirements, which would add to the cost burden of producing H1.2 farm-totara timber suitable for structural applications. Nevertheless, options for the boron treatment of farm-totara timber, based on diffusion methods, should be properly investigated.

Next steps

The failure to achieve adequate boron penetration into farm-totara using a modern standard pine treatment process suggests prioritising research effort into determining natural durability of untreated sap & coloured farm-totara timber. Wet-frame tests, as previously undertaken for radiata pine, Douglas fir, cypress and other species by Scion, subjecting timber to permanently damp conditions, have not been undertaken for farm-totara (Doug Gaunt, Scion, pers comm.). Results from such testing would provide evidence of comparative durability performance and would likely be necessary before inclusion within the Building Code under the same conditions as untreated Douglas fir for structural applications.

Framing natural durability tests

Scion has developed an accelerated framing trial method where the relative durability of alternative framing products is tested in comparison to boron H1.2 treated framing as a benchmark (Tripti Singh, Scion, pers comm.).

However, it is questionable whether H1.2 as a treatment level should be the de-facto "durability performance benchmark" for structural applications.

Durability performance

Durability performance under the NZ Building Code has historically been measured as years in service. Framing, or other structural timbers, are required to last for minimum of 50 years in dry condition. However, because framing timbers are hidden inside a wall or roof cavity, there is a risk of moisture entrapment. In response to the leaky building crisis it was recognised that structural timber needed to be sufficiently durable such that water ingress could be remedied before the framing decayed. The time that this would reasonably take has never been defined: instead, only the treatment level of H1.2 was considered as adequate to cope with fungal and insect risks for normal framing use and construction practices in New Zealand.

Naturally durable timbers do not have a performance benchmark, in terms of years in service without decay under situations of moisture ingress. Such a definition would allow testing against a meaningful benchmark. In other words, durability performance should be defined before tailoring treatment levels to achieve the desired level of performance.

If H1.2 treatment defines the level of durability required under situations of potential moisture ingress, as structural timber, then naturally durable timbers would need to meet or exceed this durability benchmark through comparison tests such as Scion's wet-framing tests. The other benchmark is set by untreated Douglas fir in houses of low-risk design. If untreated farm-totara were tested as less durable than H1.2 radiata but more durable than untreated Douglas fir, it would be reasonable to claim suitability for structural use in houses of low-risk design.

Farm-totara timber samples supplied for wet-frame testing

Scion have indicated that they will do the wet-frame test for farm-totara timber if the Northland Totara Working Group supply the necessary timber sample material (Doug Gaunt, Scion, pers comm.). We understand that this is the same test that was used as a basis for un-treated Douglas-fir timber to be used for framing. To this end, as part of this project, members of the Northland Totara Working Group have supplied a range of sample boards to meet the following specifications as required by Doug Gaunt, Scion:

- 10 x (90x45x900) Sapwood/Intermediate, Structural Grade.
- 10 x (90x45x900) Sapwood/intermediate, Structural Grade (H1.2 treated)
- 10 x (90x45x900) Heartwood/intermediate, Structural Grade.

Samples comprising rough-sawn, air-dry farm-totara timber from 4 different properties were visually graded and dispatched to Scion on the 12th April 2016.

We understand that these have been received and await preparation for the wet-frame testing.

Visual grading of boards according to colour evident on end grain and radial position in log. In this case sapwood/intermediate grade.

Potential issues

Difficulty in visually distinguishing sapwood/intermediate wood and what may constitute ‘true’ heartwood have been encountered. In regards to the timber properties of regenerated farm-totara timber, any assumptions based on old-growth totara timber should be abandoned, and characterisation studies on wood properties of ‘farm-totara timber’ should be approached as if it were an unfamiliar species. There is a clear need to both accurately describe and understand the wood characteristics of this timber resource (e.g heartwood/sapwood content, gradients between these and relative durability of each). The implications of these need to be considered with respect to conducting the wet frame-test on a limited sample size. Therefore an adequate sample size from across the sapwood to heartwood gradient should be tested and before testing commences this issue should be discussed with Scion Scientists to confirm adequacy of the sample size and clarify required outcomes.

Characterisation of farm-totara timber

Greg Steward, research scientist with Scion, has commenced some preliminary studies on relative sapwood/heartwood content of planted totara trees. As part of this project, Paul Quinlan, on behalf of the Northland Totara Working Group members, supplied a range of timber samples, to trial methods of testing for the presence of heartwood.

Identifying and quantifying the relative levels of sapwood/intermediate/heartwood in immature and mature totara trees is essential. Also, understanding and quantifying the relative natural durability levels of each of these and confirming the practical ability to visually distinguish them would open pathways that lead to suitable end-uses, markets, and Building Code compliance. Therefore, characterisation of the wood and timber properties of farm-totara is identified as a critically important early research step.

Sample profile from a disc showing what appears to be a gradient of colouration across the radial section.

Example of 3 distinct colouration zones at the end of a top-log

Conclusions

Studies confirm farm-totara to be a high-quality native timber with strong market interest. However, at present, uncertainty around building code compliance, particularly relating to durability performance, is a major impediment to the commercial use of farm-totara timber. This severely limits the potential markets and value of the timber. Establishing Building Code compliance is likely to have an immediate and significant impact on market demand and greatly increase the potential value of the resource to land-owners.

Barriers to compliance could be overcome by targeting research to prioritise achieving code-compliance for products with greatest market potential, and according to a plan that carefully considers costs, time-frames, pathways, decisions, outcomes and consequences as a decision tree.

Because there is currently a limited knowledge-base on timber properties that influence selection of marketable products, considering market potential for products is interdependent on determining code-compliance. Therefore, some assumptions would be required in prioritising research and testing. For example, testing of durability performance is a clear priority, but this needs to be considered in relation to products and timber properties. Timber properties that affect natural durability or impregnation with chemicals, or processing/drying issues all contribute to decisions on product mix options.

It is suggested that two visual grades, based on timber colour, should be tested for durability in all applications, these being “heartwood + intermediate wood” and “intermediate wood + sapwood”. Until more is understood about relative durability according to tree age and radial position in tree, such differentiation, although presumptive, is based on industry discussions on likelihood of significant differences in durability performance that would lead to commercial products suitable for purpose.

Durability performance testing

The clear priority is to test relative durability performance of sapwood, intermediate wood and heartwood. Options include accelerated decay methods that compare the resulting levels of durability with Hazard Class preservative treated radiata pine (refer Appendix: D). The relationship between colour of farm-totara timber and durability would need to be tested concurrently. Accelerated decay methods could be used to compare different identifiable colour-based grades with H3.2 treated radiata pine (for assessing compliance as decking applications) and H3.1 radiata (for assessing compliance as cladding applications).

For structural applications the Scion wet-framing test would provide comparative performance levels with H1.2 radiata and untreated Douglas fir. The results would give alternative paths to compliance. If farm-totara were demonstrated to be more durable than untreated Douglas fir and less durable than H1.2 radiata, then untreated farm-totara would be limited to buildings of simple design, in the same manner as untreated Douglas fir is. Testing should give consideration to possible differences in durability performance between “heartwood + intermediate” and “sapwood + intermediate” based on visual differentiation of timber colour.

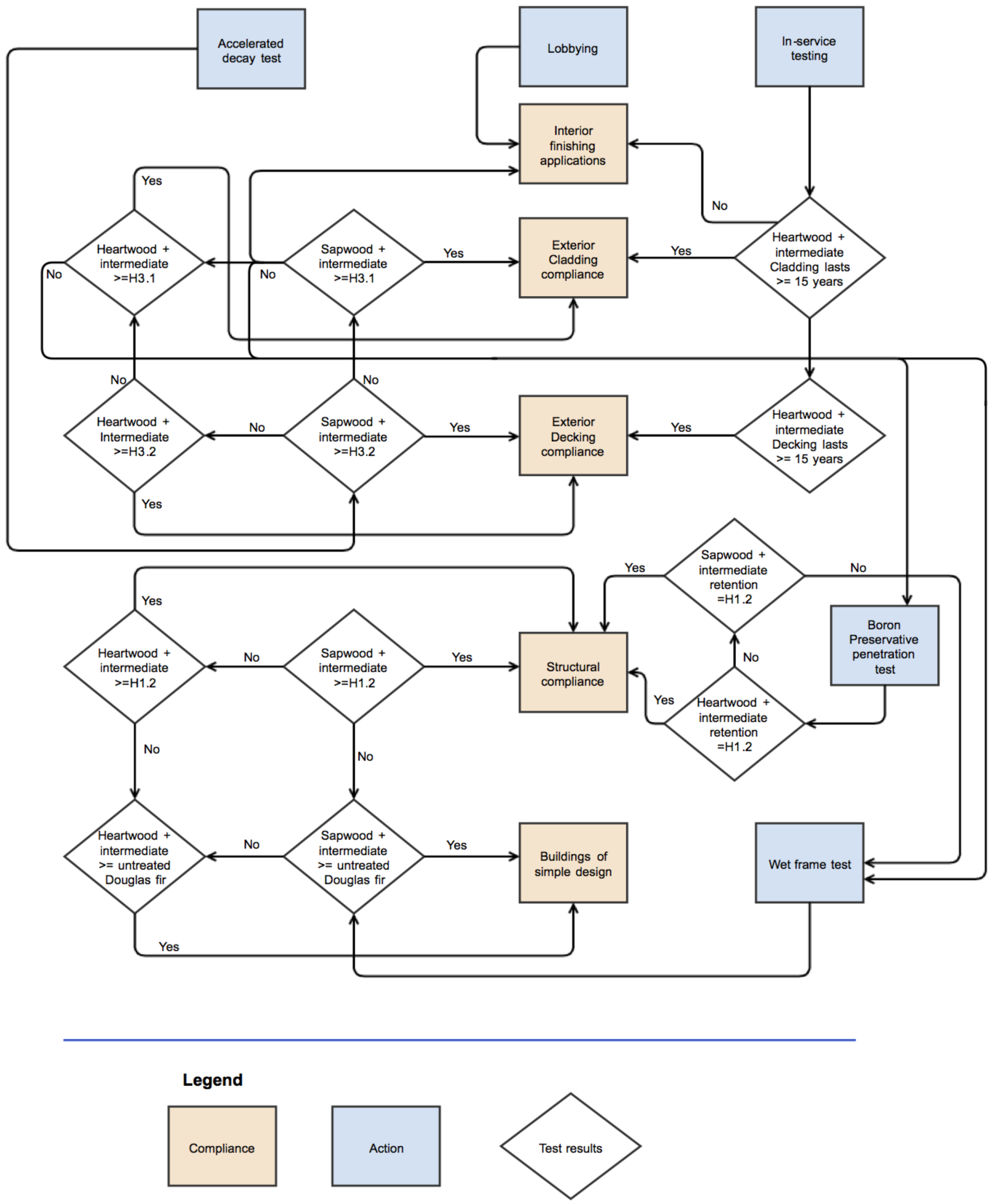
Submissions to MBIE to provide a Verification Method for testing durability performance for structural timber should be pursued by industry so that it is clear what the requirements are in terms of testing methods for structural applications.

Preservative treatment options for farm-totara also need to be considered, either concurrent with or after the wet-framing test trials. Boron treatment options should be pursued, especially traditional diffusion methods because slow air-drying is standard practice for farm-totara, which may facilitate cost-effective boron diffusion treatment methods. Diffusion methodology would need to be tuned to consistently achieve the requirements of NZS 3640 before pursuing this path to compliance. Industry would need to be aware that verification of treatment levels would be required on a producer-by-producer basis.

If compliance were determined by tests on farm-totara products, documents could be prepared for industry and the market on how to prepare Alternative Solutions. These documents would also form the basis of preparing a case for inclusion in the next revision of NZS 3602, for farm-totara timber to become an Acceptable Solution for the specified application.

Submissions should be made to include farm-totara for interior finishing applications in the next revision of NZS 3602, based on well documented experience and examples showing that the timber is durable for more than 5 years in service.

Flowchart on compliance paths, assuming two timber grades based on visual differentiation of wood colour



Recommendations

This review of the issues and barriers that constrain market development for farm-totara timber products under the New Zealand Building Code is aimed at identifying pathways to code-compliance. The following recommendations are provided in order to develop and implement an optimal and practical pathway for acceptance of farm-totara within the Building Code.

These recommendations focus on the research required to fill knowledge gaps regarding wood properties of farm-grown totara timber and the performance issues that need to be understood to achieve compliance with the Building Code.

1) Submissions for farm-totara to be included in NZS 3602 for interior flooring, non-load-bearing interior wall framing and stair treads, risers and handrails where protected from the weather and dampness.

2) Explore opportunities for use of farm-totara as a decorative interior face in cross laminated panels.

3) Characterise and describe the wood properties of farm-totara timber, particularly the relationships between apparent colour of the timber and natural durability levels of sapwood, intermediate wood and heartwood. This needs to form the basis of trials where durability performance is being tested.

4) Undertake accelerated decay 'wet-frame test' trials, to compare durability performance of structural timber subject to moisture ingress, between farm-totara timber and:
   a) H1.2 *Pinus radiata* and
   b) Untreated Douglas fir.

5) Trial use of sapwood farm-totara timber as exterior window joinery and test coatings as a method of achieving 15 years + durability performance in this application.

6) Trial thermal modification of farm-totara timber and:
   a) compare its durability performance with radiata pine under the same modification process and with radiata H3.2
   b) test strength performance compared with imported cedar as exterior joinery
   c) Set out any conclusions regarding suitable end uses/markets for thermally modified farm-totara based on those test results.

7) Trial durability performance of farm-totara sapwood as external cladding and test coatings as a method of achieving 15 years + durability performance in this application.

8) Trial durability performance of farm-totara in-service as external decking to test achieving 15 years + durability performance in this application and compare with CCA radiata H3.2.

9) Publish the test results, so these are available for use in Alternative Solutions.

10) Advocate for the appropriate amendments to be made to NZS 3602, to be fully inclusive of farm-totara as an Acceptable Solution for end-uses, according to the results of the above trials and tests.

Acknowledgements

The author wishes to acknowledge the support from the organisations and individuals that have enabled this project to be undertaken. These include; the Ministry for Primary Industries (through the Sustainable Farming Fund), Tane's Tree Trust and the New Zealand Farm-Forestry Association, (including the Indigenous Forestry Section), the Northland Totara Working Group members Paul Quinlan and David Bergin for assistance in finalising this report, Michael Hayes & Geoff Cookson, for their time and donated sample boards of timber for testing, and saw-miller, Shane Hyde, for his time and the use of his band-saw in re-sizing some of the timber samples. The time and input from Robin Curtis, CEO of NZ Sustainable Forest Products, is also acknowledged and much appreciated.

Appendices

Appendix A: Totara and the New Zealand Building Code – Compliance Paths

Compliance with the Building Code can be demonstrated using various pathways. Some pathways ***must be accepted*** by the building consent authority as meeting the performance requirements of the Building Code[1].

Compliance Paths that must be accepted by building consent authorities as meeting the performance requirements of the Building Code

Acceptable Solutions and Verification Methods

Acceptable Solutions are simple step-by-step instructions that offer one way to comply with the Building Code[1].

Verification Methods are prescriptive tests or calculation methods that offer another way to comply with the Building Code[1].

Verification Methods and Acceptable Solutions are prepared by the Ministry of Business, Innovation and Employment in accordance with section 22 of the Building Act 2004. Verification Methods and Acceptable Solutions are for use in establishing compliance with the New Zealand Building Code[2].

Acceptable Solutions and Verification Methods provide details for construction that, if followed, result in compliance with the Building Code. A design that complies with an Acceptable Solution or Verification Method ***must be accepted*** by a building consent authority as complying with the Building Code[1].

There is at least one Acceptable Solution or Verification Method for compliance with each of the Building Code clauses. For example, for Clause B1 of the Building Code there are two Verification Methods and three Acceptable Solutions, referred to by their Building Code clauses and unique identification numbers. That is, B2/AS1 is Clause B2 of the Building Code, Acceptable Solution 1[1].

Durability
Verification method 1 of Clause B2 (B2VM1) *Durability evaluation* take into account the expected in-service exposure conditions of a building component and offers three methods to prove durability performance (1.0.1):

1. In-service history
2. Laboratory testing
3. Comparable performance of similar building elements.

Two NZ Standards, NZS 3640 and NZS 3602 offer Acceptable Solutions for timber durability.

Structure
Verification Methods for structural integrity are provided in NZS 3603, while Acceptable Solutions are provided in NZS 3604.

Timber components ***need to meet both structural and durability requirements*** to comply with the Building Code.

Product certification - Codemark

The Building Act contains provisions for a voluntary product certification scheme that enables product manufacturers to have their products certified as meeting nominated performance requirements of the Building Code[1].

Building products or methods that are used in accordance with a product certificate ***must be accepted*** as complying with the Building Code[1].

Codemark product certification provides a way for a product to meet the requirements of the Building Code. CodeMark is an unchallengeable form of product assurance. Building consent authorities (BCAs, usually councils) must accept a product certificate as evidence of compliance with the Building Code, provided the product is used in accordance with the use and limitations defined on the certificate[6].

Only accredited product certification bodies can evaluate products for CodeMark and issue CodeMark certificates. They must follow the CodeMark Scheme Rules when doing so. The Joint Accreditation System of Australia and New Zealand (JAS-ANZ) is the body responsible for assessing and accrediting product certification bodies[6].

The Building (Product Certification) Regulations 2008 prescribe the[6]:

- criteria and standards for accreditation as a product certification body, including the fees payable to the accreditation body
- criteria and standards for certification of products
- minimum content for product certificates

CodeMark certificate holders have ongoing responsibilities to ensure their certified product continues to be manufactured to the same standards, levels and quality as those against which it was evaluated and certified. To keep certificates valid, the requirements of the Codemark Scheme Rules need to be followed and annual auditing undertaken by the product certification body[7].

Determinations

A determination is a binding decision made by the Ministry of Business, Innovation and Employment. It provides a way of solving disputes or answering questions relating to the Building Code and territorial authority/building consent authority/regional authority decisions under the Building Act[1]. A determination meets the performance requirements of the Building Code that is covered.

Although a determination must be accepted by the building consent authority as meeting the performance requirements of the Building Code, the issue under question is specific to that building consent authority and might only be seen as a guide by other BCA's.

Compliance Paths that do not need to be accepted by building consent authorities as meeting the performance requirements of the Building Code

Alternative Solutions

The Building Code describes how completed building work must perform rather than how a building must be built. Any product or system can be used in a building provided it meets the relevant performance requirements of the Building Code[9].

An Alternative Solution is a building design or proposed construction that differs, in part or wholly, from the solutions offered by the Acceptable Solution or Verification Method. This must demonstrate compliance with the performance requirements of the Building Code ***to the satisfaction of the building consent authority***.[1] An alternative solution must provide evidence that it meets performance criteria of the Building Code and allows for innovation and uniqueness. Compliance needs to be clearly established for the Building Consent Authority to be satisfied "on reasonable grounds" and issue a building consent[8].

An alternative solution can include a construction material that differs completely or partially from those described in the Acceptable Solutions or Verification Methods. Where an alternative solution is for a product, sufficient evidence that it complies with the requirements of the Building Code might include[8]:

- Comparison with Acceptable Solutions or Verification Methods.
- Comparison with a product previously accepted by a BCA.
- Comparison with a determination issued by MBIE.
- Manufacturers literature on a proprietary product
- Appraisal
- In-service history
- Expert evidence

This approach is very much in line with product assurance (see below).

Products

For a product to comply fully with an Acceptable Solution or Verification Method, evidence must show that it meets the requirements of these. An alternative solution offers another way for products to meet the relevant performance requirements of the Building Code[9] and involves evaluating the product against criteria that, if met, will demonstrate compliance with a particular Building Code clause. This might involve[9]:

- comparing the product against a relevant product standard referenced in an Acceptable Solution or Verification Method
- comparing the product to another document (eg a New Zealand or overseas standard, other technical information, test
  results or research)
- look at in-service history and performance of a similar product within New Zealand or in similar conditions
- identify any relevant determinations issued by the Ministry. Is there a determination on a situation where a similar product is specified? As determinations relate to a particular case, their application may be limited. However, they do provide sound guidance on the application of the Building Act and Building Code at a particular time.

Evidence should therefore be established to demonstrate where the product complies with clauses of the Building Code. Evidence includes product assurance claims (technical information, independent assessments, industry-based schemes, appraisals) and/or product certification (CodeMark).

Product Assurance

The product assurance approach developed in 2010, is about providing evidence and information that the product complies with the Building Code. Product assurance offers manufacturers and product suppliers cost-effective ways to show Building Code compliance and therefore market acceptance[3]. Manufacturers and suppliers may choose less stringent levels of assurance than Codemark certification, such as product technical statements (PTS's) or independent testing for products that are already well used and accepted in the New Zealand building industry[6], or where the Building Consent Authority is easily satisfied that their product is Building Code compliant.

Demonstrating that a product meets the requirements of the relevant Building Code clauses requires ***reliable evidence*** (such as technical information, independent assessments, appraisals, product certification or industry-based schemes)[4]. Claims made by the manufacturer or supplier must be backed up by technical information that[5]:

- meets Building Act obligations under section 14G (manufacturers' and suppliers' responsibilities)
- shows compliance with the Building Code
- assures users the product is made to the same specification and quality as specified.

Claims can be supported with technical opinions, independent assessments/appraisals, laboratory testing or proof of in-service history[5].

At a minimum, such ***evidence*** must include[5]:

- relevant technical information
- a purpose and use statement that includes any limitations relating to the product's use
- clear design, construction and installation information and support for designers and builders
- clear maintenance information for the product including what is required and what the impact would be on ongoing performance, especially durability (if maintenance is not done to the required level).

For evidence and information provided to Building Consent Authorities and others in the decision chain to be ***reliable***, this must be[5,9]:

- comprehensive (showing how the products performance complies with Acceptable solutions, Verification methods or standards cited in these).
- credible (an appropriately qualified organisation carrying out product assessments and making claims only where competent to do so)
- relevant (testing and evidence that relates to the product)
- controlled (where, when and how the product can be used so that it is fit for purpose, including limitations).

Information can also be provided about design instructions, links to installation manuals or similar.

Fact-based performance claims such as statistical data about the product's past performance should be provided rather than anecdotal evidence. Factual claims demonstrating a history of successful manufacture, sale and use in relevant situations or markets might show how the product performs in different local conditions in New Zealand such as in high wind zones, corrosion zones, seismic zones, or zones with high levels of UV exposure, and would include the effect these conditions have on product life[5].

Where the level of risk of not complying with the relevant requirements of the Building Code is high, more comprehensive evidence would need to be provided.

Product technical statement (PTS)

Product technical statements were developed by MBIE as a tool for products or systems to meet Building Code obligations. Key details are summarised to provide reliable technical information and help for[10]:

- designers and specifiers to assess and specify building products
- Building Consent Authorities to consent building work
- Product support to enable builders and homeowners to receive clearer information about installation and maintenance
- meeting Building Act responsibilities

A PTS should include the following information[10]:

- a description of the product and its intended use
- details of the manufacturer (if issued by a supplier)
- date of issue (or revision) and relevant links so users can confirm they have the latest version
- purpose and use (how the product can be used and any limitations on that use)
- any conditions on the use of the PTS
- a statement of the Building Code clauses relevant to the product and clear links to evidence to support compliance claims (such as relevant test reports, technical opinions, product certification details or other supporting information)
- links to design, construction and installation instructions
- links to maintenance requirements so the building owner can maintain the product effectively and a description of potential consequences of not carrying out specified maintenance
- contact details for technical support; ideally for New Zealand organisations that can provide product advice and assistance.

(**N.B.** - MBIE have a product technical statement tool)

Independent appraisals

Appraisals are independent technical opinions of a building product or system's fitness for purpose. They have no legal standing but can be used as evidence of Building Code compliance through a process of testing and verification.

Producer statements

A producer statement is a statement supplied by or on behalf of an applicant for a building consent, or by or on behalf of a person who has been granted a building consent. It is a statement that certain work will be, or has been, carried out in accordance with certain technical specifications.[1]

Producer statements were introduced by the former Act and are no longer expressly referred to in the Building Act. A building consent authority may, at their discretion, accept and consider a producer statement as part of the plans or specifications for a building consent. This will assist the building consent authority in deciding whether it is satisfied on reasonable grounds the provisions of the Building Code will be met if the building work is completed in accordance with the plans and specifications. A building consent authority should have a formal procedure or policy in place for the use and consideration of producer statements, especially if a producer statement(s) will be required to prove building work complies with a building consent.[1]

References

1. New Zealand Building Code Handbook (2014)
2. Timber treatment has just got simpler (Build 124)
3. Product assurance in the New Zealand building market
4. Showing your products comply with the Building Code
5. Establishing and providing information and evidence about your product
6. CodeMark as a product certification scheme
7. How CodeMark works
8. Alternative solutions for compliance with the Building Code
9. Product Assurance Decision Tool (pdf)
10. Creating and providing a product technical statement

N.B. – also see: New Zealand Building Code Handbook. The preface describes the status of Verification Methods and Acceptable Solutions and explains alternative methods of achieving compliance.

Appendix B: Totara and the New Zealand Building Code - Clause B1: Structure

Performance requirements around loads that buildings are subject to is set by Building Code clause B1 Structure, to ensure buildings are stable and withstand physical conditions.

For structural timber Compliance Document B1 requires

- NZS 3603 as the Verification Method (i.e. Prescriptive tests or calculating methods) or
- NZS 3604 as the Acceptable Solution (i.e. Prescriptive step-by-step methods).

NZS 3604 *timber framed buildings* only applies to radiata pine and Douglas fir, so an acceptable solution is not available for farm-totara to be used for structural applications. However, Characteristic Stresses have been determined for Farm Forestry Timber's No. 1 structural grade and thus can be used as a verification method for farm-totara timber to comply with the building code under NZS 3603 *Timber Structures Standard*.

For more information visit the NZ Farm Forestry website.

Appendix C: Totara and the New Zealand Building Code - Clause B2: Durability

The durability requirements for structural timber used in buildings are provided in clause 2 of the New Zealand Building Code.

The current rules

NEW ZEALAND BUILDING CODE clause B2 covers the Acceptable Solutions (B2/AS1) and Verification Methods (B2/VM1) used to establish compliance with the durability requirements of the Building Code. The most recent edition is Amendment 8, issued on 14 August 2014.[1]

Verification method B2/VM1 gives options that may be accepted by the consenting authority. These include[1]:

- verifiable in-service history for known systems or materials – known length of service in the same environment, frequency of use without adverse results or other results that demonstrate the required durability
- laboratory testing, verifying degradation rates, testing relevance to the situation of proposed use and durability period, methods of testing and so on
- similar material comparisons – demonstrating similarity in composition, use in the same environment, required maintenance, conditions of use and so on. Where such a direct comparison is not possible, the building element shall be independently assessed to determine the degree of similarity.

Acceptable solutions from standards such as NZS 3602 and NZS 3640 that relate to timber durability are referenced by B2/AS1[1]

B2/AS1 Table 1 (page 17) gives the nominated durability of building elements to comply with the Acceptable Solution. **Structural elements like floors, walls, bracing or structural fixings, items difficult to access or replace or building elements where failure would go undetected during normal maintenance of the building are required to have a life of not less than 50 years (i.e. the life of the building).**[1]

Radiata pine and Douglas fir framing - the current situation

To achieve a life of not less than 50 years as required for structural applications under the Building Code, radiata pine or Douglas fir treatment levels are now:

- a minimum treatment of H1.2 for radiata pine and Douglas fir solid timber framing
- remove the option of H3.1 radiata pine as a structural or framing timber
- permit H3.1 (LOSP azoles as required in NZS 3640 Table 6.2) treatment for LVL pine to satisfy the requirement of H1.2 as a minimum treatment for radiata pine and Douglas fir.

Timber framing under Clause B2 Acceptable Solution 1 B2/AS1 allowed a single hazard class for treatment of H1.2 as of 4 April 2011 (See Build 124). Since then H1.2 treatment is required for Douglas fir (There is an exception for Douglas fir) and radiata pine structural timber. However, cantilevered deck joists and associated framing must be treated to H3.2.

The relevant standards (NZS 3640 or 3602) themselves were not amended with these changes, but B2/AS1 was instead updated to modify the requirements of these standards. The changes related to only radiata pine and Douglas fir enclosed by cladding.

Alternative species

Allowance for other species is provided by NZS 3602, which was amended in B2/AS1 only for radiata pine and Douglas fir.

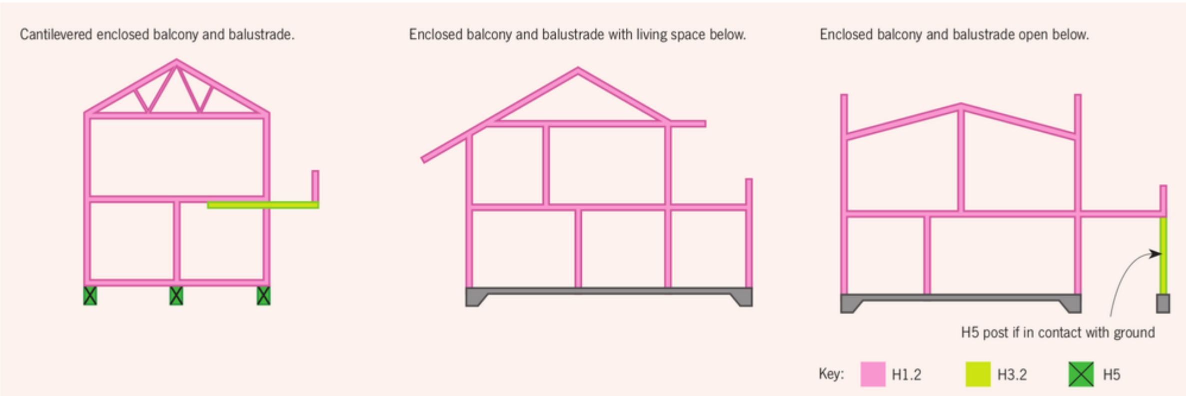
Other species continue to reference NZS 3602. Totara is not referenced in NZS 3602.

Douglas fir- the exception

The exception to H1.2 treatment was that untreated Douglas fir framing has been included for use in defined 'low-risk' designed houses. This was because Douglas fir was "shown to have some natural durability over that of radiata pine (though not as good as H1.2 treated framing)" (John Harper, Senior Advisor – Building Standards, Department of Building and Housing).

For structural use of other species, NZS 3602:2003 Tables 1 and 2 continue to be the only reference.

Treatment requirements for timber framing.[2]



Treatment requirements for framing and other timber uses.[2]

LEVEL	SPECIES	BUILDING ELEMENTS

LEVEL	SPECIES	BUILDING ELEMENTS
Floor framing protected from weather but exposed to ground atmosphere		
H1.2	Radiata pine Douglas fir	Jack studs, subfloor braces, bearers, wall plates, floor joists to the subfloor, blocking, walings and battens, nogs and diagonal boards.
H1.2	Radiata pine Douglas fir	Interior solid wood flooring for ground floors.
Enclosed roof framing and trusses		
H1.2	Radiata pine Douglas fir	Sarking and framing not protected from solar-driven moisture through absorbent cladding materials.
H1.2	Radiata pine Douglas fir	Enclosed flat roof framing and associated roof members.
H1.2	Radiata pine Douglas fir	Enclosed skillion roof framing and associated roof members.
H1.2	Radiata pine Douglas fir	Valley boards and boards supporting flashings or box gutters, and flashings to roof penetrations and upstands to roof decks.
H1.2	Radiata pine Douglas fir	All roof trusses, including gable-end trusses, roof framing, ceiling and eaves framing, purlins and battens.
Enclosed wall framing protected from the weather		
H1.2	Radiata pine Douglas fir	Framing and other members within or beneath a parapet.
H1.2	Radiata pine Douglas fir	Framing and other members within enclosed decks or balconies (see H3.2 for cantilevered decks).
H3.2	Radiata pine	Framing and other members within enclosed cantilevered decks (including joist trimmers, nogs and blocking).
H1.2	Radiata pine Douglas fir	Framing and other members supporting enclosed decks or balconies (including cantilevered decks).
H3.1	Radiata pine	Battens used behind cladding to form a cavity (H3.1 treatments can be either solvent-based or boron. H3.1 boron treatments supplied grey primer-painted).
H1.2	Radiata pine Douglas fir	All other exterior wall framing and other members including exterior and boundary joists.
Internal wall framing		
H1.2	Radiata pine Douglas fir	Internal walls.

LEVEL	SPECIES	BUILDING ELEMENTS
Mid-floor framing		
H1.2	Radiata pine Douglas fir	All mid-floor framing, including boundary joists, ceiling framing and ceiling battens and double top plates.
Interior flooring		
H1.2	Pinus species Douglas fir	Interior flooring.
Other framing		
None	Radiata pine Douglas fir	Wall framing and roof framing (including trusses) protected from the weather, in unlined and unoccupied farm buildings and outbuildings, except buildings with high internal humidity, such as saunas, spas and so on.
H3.2	Radiata pine	Framing exposed to the weather and above ground.
H4	Radiata pine	Framing such as fence posts and landscape timbers that is exposed to the weather and is in contact with the ground.
H5	Radiata pine	Framing such as house piles, poles and crib walling that is exposed to the weather and is in contact with the ground.

Note 1: For structural use of other species, refer to NZS 3602:2003 Tables 1 and 2.
Note 2: For non-structural use of radiata pine, Douglas fir and other species, refer to NZS 3602:2003 Table 3.
Note 3: A higher treatment level also satisfies the level specified in this table.
Refer to NZS 3602:2003 for other framing choices, such as larch or macrocarpa.

The History - Key historical dates for timber treatment regimes

Wet boric or boron salts timber treatments were first introduced in 1952 – before that, native timber and some of the first radiata pine framing was used untreated. From 11 September 1995, NZS 3602:1995 *Timber and wood-based products for use in building* allowed the use of untreated timber for framing provided it was kiln-dried and that its in-service moisture content did not exceed 18%. The change in the standard was cited in Building Code compliance document B2/AS1 on 28 February 1998. (Any use of untreated kiln-dried timber before this would have to have been consented as an Alternative Solution.)[4]

From 1998 to April 2004, homes were commonly constructed with untreated kiln-dried timber framing, which will readily deteriorate if it is regularly wetted. During this period, there was also limited use of H1.1 LOSP (which has no resistance to rot), H1.2 boric, H3.1 LOSP and some H3.2 CCA-treated framing.[5]

On 9 March 2003, the Building Industry Authority (BIA – the forerunner to both MBIE and DBH) issued BIA directive 23, which required that treated timber be used for all consents issued from 1 April 2004. Consents already issued that included use of untreated timber remained valid as long as the buildings were completed before 1 April 2005.[4]

In April 2004, Acceptable Solution B2/AS1 [A prescriptive design/construction solution published by the Ministry of Building, Innovation and Employment (MBIE), Building and Housing Group. Where proposed construction follows an Acceptable Solution exactly, it must be accepted as being code compliant for that specific Building Code clause.] adopted an amended version of NZS 3602, which required the use of treated timber where there was any risk of water getting into the timber frame.[5]

In April 2011, Amendment 7 to B2/AS1 further amended the treatment requirements of NZS 3602 to allow the use of H1.2 boron-treated radiata pine and Douglas fir framing within a closed space, except for cantilevered balcony floor joists and associated enclosed balcony wall framing where H3.2-treated timber was required. The amendment allowed the use of untreated Douglas fir in buildings with very low weathertightness risk.[4]

Background to Amendment 7 B2/AS1

Changes to the Acceptable Solution for Building Code Clause B2 (Durability) were proposed by the Department of Building and Housing in 2010, with consultation closing in October 2010.

Proposals included adopting H1.2 as the single hazard class for timber framing inside the building envelope, except for the critical performance of cantilevered deck joists, which would need to be treated to H3.2 hazard class. Principles behind the changes included adequate protection for homeowners and Encouraging fit for purpose products.

A summary of key issues from the consultation on Timber treatment changes was released in March 2011.

The discussion document outlined how when used appropriately, timber is a versatile and durable building material. Preservative treatment of timber enhances its durability, which is especially important in situations where the timber may be subject to inadvertent wetting.

The discussion document[6] stated that:

- The purpose of preservative treatment in framing is to provide protection from exposure during construction and allow time to discover and repair framing if inadvertent leaking occurs throughout the life of a building.
- Treating all timber within the house will simplify timber selection, reduce complexity and risk of mistakes, thus avoiding remedial costs where untreated timber is used in inappropriate locations.
- Research conducted over the past eight years on the durability of treated framing has confirmed that timber treated to the H1.2 retention level of boron (0.4% m/m BAE) provides satisfactory resistance to decay and the spread of fungi within the building if the framing gets wet.
- favourable results on leaching of boron from significant research within New Zealand, mainly by Scion and more recently by DBH and BRANZ,

- Boron treatments have been used in New Zealand framing for more than 50 years and there is no historical documented evidence that boron-treated wall frames would be at risk to rapid and extensive decay in buildings.
- all timber framing elements within the building envelope are protected from the weather, but at risk of occasional wetting. Improvements to design and construction practices resulting from amendments to E2/AS1 have significantly reduced the risk of moisture ingress.

In one of the longest on-going accelerated studies[6] that has been published, untreated pine framing failed at 18 months whereas the boron-treated framing was almost sound after 6 years except for some superficial soft rot in the very wet sections.

In ongoing accelerated decay trials conducted by Scion, boron-treated timber continues to resist fungal attack after 7-8 years exposure[6]. The boron treatment was at the current H1.2 retention and the timber has been exposed to moisture and periodic wetting over the duration of the trial. Boron is not a leach-resistant preservative and some loss in boron concentration has been documented in this study. However the approved H1.2 concentration has more than allowed for any depletion over the test period and for the ongoing protection of the timber.

Additional independent research conducted by Scion and BRANZ confirms that while boron is a leachable preservative treatment, the level of treatment is effective when timber is wet for a prolonged period and under conditions favourable to fungal decay development. Even at low residual boron levels, the boron will continue to protect the timber from decay.

The toxic threshold for brown rot (the decay type most likely to develop quickly in softwood timber framing), expressed as boric acid equivalent (BAE) is 0.15 – 0.20% m/m. So the H1.2 retention of 0.40% m/m gives a 100% safety factor, ie double the toxic threshold.

The trial is of commercially available New Zealand radiata framing, treated to two levels of boron (BAE at 0.4 % m/m and 0.8% m/m) which is consistent with recognised commercial treatments. The twelve month results were analysed in March 2010, and results indicate average retentions across each batch of test samples of 0.4% m/m and 0.6% m/m respectively. The results support the adequacy of H1.2 boron for treatment of general framing timber, as outlined in the proposal.

Conclusion: Based on this evidence, the Department considers that boron as a preservative treatment at the current H1.2 retention (0.40% m/m Boric Acid Equivalent) provides effective protection from insect borers and fungal decay for all framing elements.

Building practices have improved due to regulatory changes and greater awareness of good building practices. Drained and vented cavities, better detailing of penetrations and junctions and around windows and doors, and a greater understanding of the 'risk' profiles of certain types of buildings to leaking have been introduced to improve weathertightness. The risk of framing getting wet is greatly reduced, as evidenced by the very much lower incidence of weathertightness failure since 2004.

The total volume of structural timber used in New Zealand housing (new houses and additions and alterations) and non-residential buildings has been estimated from the most recent BRANZ survey of trends in timber use at over 870,000 cubic metres per annum.

Amendment 7 - Issues raised in consultation

Whether higher hazard classes should be allowed.

The Department encourages the use of H1.2, but acknowledges that designers may have particular reasons to use higher classes in certain situations. It is therefore continuing to allow higher treatments to be used (supported by sector education).

Whether roof trusses need to be treated.

In the interests of clarity, simplicity and inventory rationalisation, the Acceptable Solution specifies that roof trusses are to be treated to the same level as all other enclosed framing (apart from cantilevered deck joists and framing which require a higher treatment).

Whether all enclosed deck framing should be H3.2, rather than only cantilevered deck joists and framing as proposed.

The risk profile of other enclosed deck framing is not as high as that of cantilevered decks. Cantilevered decks depend more critically on the strength of the timber to prevent collapse. Therefore, only cantilevered deck joists and framing are specified as H3.2.

Whether solvent-based azoles should be included as H1.2.

The proposal in the discussion document to exclude solvent-based preservatives from H1.2, was arrived at after considerable discussions with the sector, and submissions did not raise anything new. Therefore, solvent-based azoles have not been included as H1.2.

About 75% supported the use of untreated Douglas fir for houses of low-risk design. Three key points were raised in consultation:

Whether untreated Douglas fir is fit for purpose.

The science and expert opinion support the use of untreated Douglas fir for low-risk buildings. The Acceptable Solution therefore allows the use of untreated Douglas fir for houses of defined low-risk design.

Whether allowing untreated Douglas fir creates unnecessary complexity.

The Department sought to balance simplicity, risk and the provision of a chemical-free option for consumers. Douglas fir is therefore allowed for houses of defined low-risk design.

Whether wider use of untreated Douglas fir should be allowed.

Given the support for simplification, the risk to internal framing from internal wet areas, and the risk of transferred moisture from external walls, the Acceptable Solution does not provide for untreated roof framing or internal framing in other than low-risk houses.

The untreated Douglas fir option does not apply to commercial buildings, because some uses for commercial buildings may have a higher moisture risk.

Acceptable Solutions and Verification Methods - Amendment 8 B2/AS1

B2/AS1 amendment 8 is effective from 14 February 2014 (Change to Acceptable Solution for timber preservative treatment - Codewords Issue 60 - May 2014). Amendments can be viewed and downloaded from the Acceptable Solutions and Verification Methods page. These include:

NZS 3640

1. the following as normative text: NZBC clause B2.3.1 refers to minimum durability requirements for building elements. Timber used for structural purposes is required to be durable in-service for the life of the building, being not less than 50 years unless the building has a specified intended life.
   This is applicable to hazard classes H1.2, H3.2, H4, H5, and H6. Structural timber refers to timber that has been graded to characteristic strength and stiffness properties.
   The minimum requirement for a H1.2 treatment for timber framing is to provide protection in-service but the preservative treatment is not designed for extended exposure to elevated moisture content.
   Timber used for non-structural purposes, such as H1.1 and H3.1 is required to be durable in-service for a minimum of 5 years and 15 years respectively.
2. Clause 6.3.1.1.1 is reinstated as "Complete sapwood penetration shall be achieved".

NZS 3602

Modifications to the previous citation of NZS 3602, in B2/AS1 amendment 7, remain unaltered.
This latest citation of B2/AS1 includes a special provision for treated LVL framing with the inclusion:
Laminated Veneer Lumber (LVL) treated using LOSP borne azoles as specified for H3.1 in NZS 3640 Table 6.2 satisfies the minimum treatment requirement of H1.2.

NZS 3604

References to NZS 3604, as modified by references to NZS 3640 and NZS 3602 noted above.

Timber and wood-based building products

3.2.1 The following Standards form an Acceptable Solution for B2/AS1 meeting the durability requirements of timber and wood-based building elements,
a) NZS 3602 Part 1 as modified by Paragraph 3.2.2.
b) NZS 3640 as modified by Paragraph 3.2.3.
c) NZS 3604, with reference to NZS 3602 (and NZS 3640), as modified by Paragraph 3.2.1 a) and b) above.

COMMENT:
The use of different timbers or timber treatments to those referred to in NZS 3602 are outside the scope of this Acceptable Solution. Where the use of a different timber or timber treatment is proposed, it shall be separately assessed for compliance with the Building Code. For example, if imported hard-wood is to be used to surface a deck, evidence that the timber was durable for a minimum of 15 years in the expected exposure conditions is required.

3.2.2 Modification to NZS 3602:

3.2.2.1 Level of treatment references to radiata pine and Douglas fir solid timber in Table 1 categories 'C', 'D' and 'E' and Table 2 category 'B' shall be replaced by Tables 1A and 2A below. Table 1A and Table 2A are to be read with NZS 3602 sections 108 to 111 inclusive, with the amendments in Paragraph 3.2.2.3 below.
Other references to radiata pine, Douglas fir solid timber and engineered wood products in NZS 3602, including Table 1 categories 'A', & 'B'; Table 2 category 'A'; and Table 3 are unaltered.
Laminated veneer lumber (LVL) treated using LOSP borne azoles as specified for H3.1 in NZS 3640 Table 6.2 satisfies the minimum treatment requirement of H 1.2.

References

1. B2 Durability overview
   By Tom Edhouse - 1 June 2015, Build 148. In our second article in the building control series, we look at New Zealand Building Code clause B2 Durability...
2. Timber treatment has just got simpler Build 124, June 2011
3. Acceptable Solutions and Verification Methods for the New Zealand Building Code Clause B2 Durability
4. BRANZ Guideline, September 2013
5. Branz Weathertight: How we got here
6. Consultation on proposals for a single hazard class for framing timber inside the building envelope, Department of Building and Housing

---

Appendix D: Totara and the New Zealand Building Code - Hazard Classes

Hazard class is defined in NZS 3640:2003 *Chemical Preservation of Round and Sawn Timber* as:

> *Describes an environment or condition categorized environments or conditions of use where timber is at particular risk of biodegradation by one or more biological agents (e.g. fungi, insects, bacteria or marine organisms).*

Hazard class specifications are described in NZS 3640:2003 as:

> H1.2 applies to timber used in situations protected from the weather, but where there is a risk of moisture content conducive to decay. (6.1)

> H3.1 applies to timber used in situations above ground, exposed to the weather – generally in non- structural applications, but including cladding used as bracing if the component is painted.(6.3)
> H3.2 applies to timber used in situations above ground, exposed to weather, or protected from the weather but with a risk of moisture entrapment. This classification is for more critical end uses and includes exposed joists and decking.(6.3)

Although Hazard Class indicates level of durability, Hazard Classes relate to the level of chemical treatment required under the Building Code, as described in NZS 3640. There appears to be the expectation that each hazard class meets or exceeds the default minimum service lives for timber components but it not clear whether component's Hazard Classes offer a benchmark or threshold for in service life under the laboratory testing Verification Method described in Clause B2VM1 of the Building Code. Defining durability with Hazard Classes does not create a level playing field between Hazard Class treated timber and naturally durable timber unless the Hazard class meets but does not exceed the service life requirement for the timber component.

In situations such as where structural timber is subject to moisture ingress, the H1.2 Hazard Class does not meet the minimum service life of 50 years. This situation is therefore an exception to the requirement of 50 years' service life and could be described as an extreme decay hazard, defined in NZS 3640 as:

> Where the decay development is more rapid than in other ground contact situations. This can be due to soil type and conditions, accumulation of nutrients in soil, or horticultural practices such as mulching or composting affecting biological activity in the soil.

Radiata pine and Douglas fir framing chemical treatment - The current situation

Light organic solvent preservatives (LOSP) treatments are not included in the H1.2 treatment category, with boron the only option for H1.2, although future amendments to NZS 3640 might include other options such as water-based azoles (Build 124).

To meet the requirements of H1.2 treatment, boron-based treatments with average cross-section concentrations of 0.4% mass/mass boric acid equivalent (BAE) or above are considered adequate to cope with fungal and insect risks for normal framing use and construction practices in New Zealand. H1.2 treatments offer 'opportunity time' for construction and detecting and repairing leaks throughout a building's life. No treatment is capable of permanently protecting framing that remains continuously wet (Build 124).

Boron has been used commercially as a timber preservative in New Zealand since the 1950s, with no known health issues for timber users or building inhabitants (Build 124).

Current methods in use for boron impregnation have been developed for radiata pine, but it is not known how well boron would penetrate farm-totara timber to H1.2 requirements using these methods.

Treatment options, hazard classes and permitted end uses

Hazard classes and permitted end uses for radiata pine (from Weathertight)

Table 2: Guide to treated radiata pine applications.

Timber to be used for	Required treatment	Timber to be used for	Required treatment
		External timber use	
piles	H5	poles	H5
enclosed subfloor framing	H1.2	exposed subfloor framing	H3.2
veranda posts supported clear of ground	H3.2	veranda posts in ground	H5
deck jack studs supported clear of ground	H3.2	deck piles in ground	H5
deck joists/bearers	H3.2	wall framing weather exposed	H3.2
decking	H3.2	roof framing weather exposed	H3.2
cladding or exterior trims unpainted, clear finished or stained	H3.2	shingles/shakes	H3.2
cladding or exterior trims painted	H3.1	exterior plywood unpainted or used as bracing	H3 CCA
fence rails and palings	H3.2	exterior plywood painted	H3 LOSP
fence posts	H4	balcony barrier exposed	H3.2
		Framing timbers (1, 2)	
external wall framing masonry veneer cladding	H1.2	external wall framing E2/AS1 20 mm cavity cladding	H1.2
balcony wall framing enclosed	H1.2	cavity battens	H3.1
parapet framing	H1.2	interior wall framing	H1.2
roof framing – low slope/skillion	H1.2	enclosed cantilevered floor joists	H3.2
roof farming – roof space	H1.2	roof sarking timber	H1.2
		roof sarking plywood membrane roof	H3 CCA
		Interior timbers	
window reveals to aluminium windows	H3.1	furniture	untreated
plywood	untreated	finishing timbers	untreated
flooring	H1.2	joinery	untreated

Note (1)	Douglas fir may be used untreated on low-risk design buildings as defined in Amendment 7 to B2/AS1.
Note (2)	H1.2 boric-treated Douglas fir may be used in all framing

applications where H1.2 boric-treated radiata pine is permitted.

Preservative treatment options (from Weathertight)

Table 3 summarises the preservative type, the hazard class that can be achieved, the identification numbers and colours.

Table 3: Preservative type and hazard class identification.

Generic type	Chemicals/fungicide	Identification number	Colour coding and branding for framing	Applicable hazard classes
Copper-based	CCA oxide (copper 23–25%, chromium 38–45%, arsenic 30–37%)	01		All
	CCA salt (copper 23–25%, chromium 38–45%, arsenic 30–37%)	02		All
	Copper quaternary (copper 56–67%, DDAX 33–44%)	90		H3.1 (1), H3.2, H4, H5
	Micronized copper quaternary (4) (copper 56–67%, DDAX 33–44%)	89		H3.1 (1), H3.2, H4, H5
	Copper azole (copper 95.8–96.4%, azole 4.2–3.6%)	58		H3.1 (1), H3.2, H4, H5
	Micronized copper azole (4) (copper 95.8–96.4%, azole 4.2–3.6%)	88		H3.1 (1), H3.2, H4, H5
Boric or boron	Boron salts (0.4% retention) boric acid equivalent (BAE)	11	H1.2 pink (1) end or face mark that is a permanent ink mark, an incised mark, a burnt mark or a plastic tag stapled to the timber – every stick of timber must be marked	H1.2
	Boron salts (0.8% retention) (2) (BAE)	11	H3.1 (edge of face branded)	H3.1
LOSP	CuN (copper naphthenate) (3)	57	H3.1 no added colour	H1.2, H3.1, H3.2
	TBTO (tri-n-butyltin oxide) (3)	56	H3.1 no added colour or green	H3.1
	TBTN (tri-n-butyltin naphthenate) (3)	62	H3.1 no added colour or green	H3.1

	Propiconazole + tebuconazole	64	H3.1 no added colour or green	H3.1
	Permethrin (insecticide only)	70		H1.1
Aqueous azoles	propiconazole + tebuconazole + permethrin	64	H1.2 green end or face branded	H1.2
	propiconazole + tebuconazole + permethrin	64	H3.1 green end or face branded (3)	H3.1

Note (1)	B2/AS1 Amendment 7 has a minimum requirement of using H1.2 timber that is boric treated for enclosed framing. Treatment of framing to cantilevered floor joists and associated framing is required to be at least H3.2 and cavity battens at least H3.1. H3.1 LOSP or water-based azole treatments are not permitted for timber framing, but water-based azole at higher retention (0.04% propiconazole and 0.04% tebuconazole) is approved for framing.
Note (2)	H3.1 boric-treated cavity battens and external finishing timbers are required by Amendment 7 to B2/AS1 to be primed before dispatch and to have a specified type of paint coating.
Note (3)	B2/AS1 Amendment 7 does not allow the use of LOSP-treated timber for framing.
Note (4)	Micronised copper is a copper compound ground into particles that are 0.005–10 microns in size and suspended in water with the aid of a dispersant.

Suitability of other preservative treatments for the single hazard class

From Consultation on proposals for a single hazard class for framing timber inside the building envelope (Department of Building and Housing 2010):

- Decay trials conducted by Scion demonstrate that the LOSP azole (propiconazole: tebuconazole 1:1) at a retention of 0.06% m/m as total azole, is suitable for the single hazard class. This LOSP treatment has not been proven at lower retentions.
- Decay trials conducted by Scion demonstrate that the current H1.2 LOSP iodocarb (IPBC) treatment does not provide the level of extended, longer-term durability required for the proposed new single hazard class.
- Tin-based LOSP treatments included in the current H1.2 and H3.1 hazard classes have already been voluntarily withdrawn from the framing market by the timber industry. These treatments, while effective in preventing decay, would not be acceptable for use as framing because of health, safety and environmental concerns and are specifically excluded.

Conclusion: Based on this evidence, the Department considers that the LOSP azole treatment at a retention of 0.06% m/m total azole provides protection equivalent to that of the boron treatment of 0.4 % BAE all elements (excepting cantilevered deck joists) within the building envelope.

On-site framing treatment

Brush-on treatment of boron glycol (with a minimum concentration of 20% BAE applied in two brush coats approximately a half hour apart) to three or four faces of 90 x 45 mm radiata framing gave effective protection against brown rot decay where exposed to wet conditions for 3 years. Some boron preservative was lost through wetting, but the preservative was redistributed through the sample. Retention of boron if coated on three or four sides was generally above the minimum 0.4% boric acid equivalent (BAE) requirement for H1.2. (October 2013, Build 138)

Boron treatment of farm-totara

References for boron impregnation of farm-totara are not available as this has not been researched to date. However, a range of treatment options are available for H1.2 boron treatment of timber, including the traditional process of dip diffusion.

Traditionally boron is applied to green sawn timber under a dip-diffusion process followed by block stacking. The treatment is allowed to diffuse for sufficient time until full penetration of sapwood has occurred (usually between two and eight weeks) before seasoning the timber. Contemporary methods for treating radiata pine require treatment of air dried timber and in a short time frame, such as pressure-diffusion or pressure treatment.

In order to assess boron penetration and retention under a contemporary pressure treatment regime, tests were undertaken at a commercial radiata treatment plant in Northland to evaluate whether standard procedure for boron-treating radiata pine would be acceptable for H1.2 treatment of farm-totara. North Sawn Lumber tested samples of timber using the fluctuation pressure process used for boron treatment of dry radiata pine. Results are available on the NZFFA website.

References

New Zealand Building Code Handbook (2014)

Appendix E - Douglas fir and durability

Untreated Douglas fir (***including*** sapwood) is allowed for structural applications under the New Zealand Building Code under certain circumstances. This is explained below and may offer opportunities for untreated farm-totara to be used under similar circumstances if durability preformance could be demonstrated to be equivalent or better.

Summary of key issues from the 2010 consultation on Timber treatment changes

Exceptions for the use of untreated Douglas fir
(Clause 3.2.2.2 B2/AS1)

Preservative-free untreated solid Douglas fir framing may be used for roof members protected from the weather, floor members protected from the weather and not exposed to ground atmosphere, and for internal and external wall framing protected from the weather provided that the building meets all of the following requirements:

- Is a stand alone, single household unit of no more than two storeys (as defined in NZS 3604) that is designed and constructed to NZS 3604.
- Is situated in wind zones no greater than 'high' as defined in NZS 3604.
- Has a building envelope complexity no greater than 'medium risk' and a deck design no greater than 'low risk' as defined by the risk matrix in the Acceptable Solution E2/AS1.
- Has drained and vented cavities complying with E2/AS1 behind all claddings.
- Uses roof and wall cladding systems and details meeting E2/AS1.
- Has a risk matrix score of no more than 6 on any external wall face, as defined in E2/AS1.
- Has a simple pitched roof with hips, valleys, gables or monopitches, all draining directly to external gutters.*
- Has a roof slope of 10° or more.
- If it has a skillion roof, the roofing material is corrugated iron or concrete, metal or clay tiles for adequate ventilation.
- Has eaves 450 mm wide or more for single-storey houses and eaves 600 mm wide or more for 2-storey houses.

From summary, published March 2011 (Building Performance, MBIE)

About 75% supported the use of untreated Douglas fir for houses of low-risk design. Three key points were raised in consultation:

1. Whether untreated Douglas fir is fit for purpose.

The science and expert opinion support the use of untreated Douglas fir for low-risk buildings. The Acceptable Solution therefore allows the use of untreated Douglas fir for houses of defined low-risk design.

2. Whether allowing untreated Douglas fir creates unnecessary complexity.

The Department sought to balance simplicity, risk and the provision of a chemical-free option for consumers. Douglas fir is therefore allowed for houses of defined low-risk design.

3. Whether wider use of untreated Douglas fir should be allowed.

Given the support for simplification, the risk to internal framing from internal wet areas, and the risk of transferred moisture from external walls, the Acceptable Solution does not provide for untreated roof framing or internal framing in other than low-risk houses.

The untreated Douglas fir option does not apply to commercial buildings, because some uses for commercial buildings may have a higher moisture risk.

Amendment 7, effective 4 April 2011, to the Compliance Document for Clause B2 Durability of the New Zealand Building Code.

Background leading to the "Untreated Douglas fir exception"

There are a number of relevant articles available and information that contributed to allowing untreated Douglas fir in B2 Acceptable Solution 1:

Responding to moisture: How do Douglas fir and radiata compare?
New Zealand Tree Grower August 2007

The first study was set up to determine the relative resistance to wetting of radiata pine and Douglas fir structural timber when both were exposed to the weather.

Following this preliminary trial, the Douglas fir Research Co- operative commissioned a more detailed investigation to assess the moisture absorption characteristics of Douglas fir from South Island sources and to compare this with that of Douglas fir from the initial trial. This trial also aimed to establish whether there were any significant differences in moisture absorption between Douglas fir sapwood and heartwood relative to that of radiata pine sapwood and heartwood.

It was concluded that Douglas fir timber shows significant positive differences from radiata pine in terms of susceptibility to moisture uptake. This trial confirmed the refractory reputation of Douglas fir, and the absorbent reputation of radiata pine. At a practical level, Douglas fir heartwood and sapwood can be regarded as equally impermeable.

A subsequent study was set up to determine whether there was any fundamental difference in the moisture uptake between Douglas fir and radiata pine framing timber when they were submerged in water.

The Building Industry Authority has stated that information showing the fundamental differences in relative moisture uptake of Douglas fir and radiata pine is needed before timber of the two species can be differentiated in the New Zealand Building Code.

For the long samples both samples of radiata pine reached 27% moisture content after 15 hours, Douglas fir sapwood took 48 hours and the Douglas fir heartwood 96 hours. Uptake was greatest in the longitudinal direction, followed by tangential then radial.

At the completion of the study, radiata pine long samples averaged 50% moisture compared to 30% for the Douglas fir.

Successful durability tests for Douglas fir
New Zealand Tree Grower August 2008

Friday offcuts - 17 July 2009

Douglas-fir has been used as an untreated framing timber for over 70 years. That changed following the Leaky Building Crisisand the resulting revision of the New Zealand Building Code.

Scion was contracted to design and run a three-year experiment to directly compare the loss of stiffness between radiata pine and Douglas-fir in leaky buildings. Indications are that some decay in untreated Douglas-fir does not cause the same amount of stiffness loss as it does in untreated radiata pine. Therefore when leaks are rectified and the framing timber dried, the structural integrity of Douglas-fir would be retained.

The purpose of these comparative tests was to provide information to allow a possible review of the status of Douglas-fir framing in the New Zealand Building Code, as regards situations in buildings where it can be used untreated or preservative (boron) treated.

Douglas Fir is back - 8th April 2011

"Douglas fir – the chemical free option". Untreated Douglas fir can be used for all the framing in traditional low risk houses (e.g., houses that are one or two storeys, and have eaves and cavity walls).

DBH confined the used of Douglas fir to low risk designs primarily for reasons of simplicity. This means that alternative solutions will be needed to use untreated Douglas fir in medium and high risk buildings and in commercial buildings. Untreated Radiata is no longer allowed.

The “Alternative Solution”
For Untreated Douglas-fir (New Zealand Oregon) in Building Construction.
This document aims to provide adequate documentation to satisfy the requirements of Territorial Authorities in approving an “Alternative Solution” for Douglas-fir (New Zealand Oregon) in building construction under the verification method B2/VM1. This documentation will be progressively upgraded to strengthen the case for New Zealand Oregon (NZO) for building construction as further research results and endorsements are obtained.
