BRANZ

BULLETIN

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SPECIFYING TIMBER

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This bulletin outlines the parameters for selecting timber for building, including an appreciation of the requirements of the relevant New Zealand standards.

It covers timber characteristics, grading, durability and moisture content.

This bulletin replaces Bulletin 451 of the same name.

1.0 INTRODUCTION

1.0.1 The choice of timber for building in New Zealand is heavily influenced by standards intended to ensure that materials used are able to achieve and maintain minimum standards of durability, safety and health for building occupants for the expected life of the building.

1.0.2 When the end use is for structure or maintaining a weathertight envelope (claddings, external joinery and trim), the controlling document is the New Zealand Building Code (NZBC) and Compliance Documents. Clauses B1 *Structure*, B2 *Durability* and E2 *External moisture* include references to a number of Acceptable Solutions that can be used to achieve compliance with the Code. They include definitions of hazard classes and the corresponding preservative treatments required to achieve the prescribed durability.

1.0.3 Where a low environmental impact solution is required, there are chemical-free alternatives in the Acceptable Solutions for some situations. There is also the option of using Alternative Solutions accompanied by evidence proving how these will meet or exceed the minimum Code requirements, particularly durability.

2.0 STANDARDS

2.0.1 Standards for timber durability, strength and quality:

- NZS 3602 *Timber and wood-based products for use in building*
- NZS 3603 *Timber structures*
- NZS 3604 *Timber framed buildings*
- NZS 3605 *Specification for timber piles and poles for use in buildings*
- NZS 3622 *Verification of timber properties*
- NZS 3631 *New Zealand timber grading rules*
- NZS 3640 *Chemical preservation of round and sawn timber*
- AS/NZS 1748 *Timber – Mechanically stress-graded for structural purposes.*

2.0.2 The only timber selections or uses not controlled by these standards are those for internal joinery and furniture, where the appearance, workability and strength determine final selection.

2.0.3 The characteristic stress values for engineering design for timber are contained in NZS 3603:1993. This standard has been recently reviewed, and revised design stress values have been published as Amendment 4. After the publication of Amendment 4 to NZS 3603, NZS 3622 was published. This standard describes procedures for the initial evaluation and daily quality control requirements necessary to verify that timber has the structural properties claimed for it. The procedures apply to both visually and machine stress-graded timber.

2.0.4 Some of the outcomes of the review of NZS 3603 and the introduction of NZS 3622 are:

- timber grades are now either 'unverified' or 'verified'
- unverified timber has been visually graded (as previously) to NZS 3631 (for example, No. 1 framing)
- the introduction of a verification system for timber grading for VSG and MSG timber in accordance with NZS 3622
- Amendment 4 provides for lower design stress for unverified timber
- there are now only four grades for visually graded timber (see 4.1)
- engineering grade has been deleted
- the grade stresses for larch, rimu, kahikatea, silver beech and hard beech have been disestablished (because these species are rarely used in new structures today)
- the former 'F' grades have been disestablished.

3.0 CHOICE OF TIMBER

3.0.1 In addition to a particular timber achieving a satisfactory durability performance, factors influencing choice of timber for use in constructing the building envelope are strength, workability, shrinkage, deflection, dimensional stability, durability, availability, sustainability, toxicity (of treatment) and cost.

3.0.2 Factors influencing choice for appearance are colour, texture and grain pattern, workability, stability, acceptance of finishes, resistance to borer attack, availability and cost.

3.0.3 Detailed specifications for timber should include size, species, finish, treatment, grade (appearance or structural) and moisture content. If selection of individual pieces for specific figuring or colours will be required, this must also be included in the specification.

3.0.4 Table 1 gives characteristics and some appropriate end uses for species of timber commonly available in New Zealand. These timbers include natives, imported exotics and New Zealand grown exotics. The origin, species and availability of any particular timber will vary widely, as will the cost. Imported timbers are generally used for more specialised end uses, where qualities such as hardness or appearance are particular considerations.

3.0.5 The use of imported tropical hardwoods and New Zealand native timber species raises concerns for many about sustainability, use of diminishing natural resources and protection of natural ecological habitats. Importers can provide end-users with information regarding origin and status of imported timbers. Specifiers who wish to ensure timbers come from sustainable sources should ask for certification of source such as that from the Forest Stewardship Council (FSC) before specifying the timber.

3.0.6 The use of recycled native timber for furniture is very popular in New Zealand. However, end-users should check carefully, as genuine recycled timber is hard to find. It is also harder to work and may be more expensive than artificially aged, newly cut timber.

4.0 TIMBER GRADING

4.0.1 Rough sawn timber is initially visually graded for either structural or appearance purposes – some mills have introduced acoustic grading for the initial evaluation of timber. Unless it is going to be visually graded to NZS 3631 as unverified timber or used as a non-structural timber, radiata pine will be graded for structural use by one of the methods approved by NZS 3622 (see 4.1 and 4.2). Most imported timber is selected for its visual appearance even if its end use is primarily structural (decking) or weatherproofing (cladding, external joinery, fascias and barge boards). Imported timber is often very specifically selected and intended for its target end use so that the manufacturer knows exactly what will be delivered to the factory door.

4.1 VISUAL GRADING

4.1.1 There are now only four visual grades for common species of structural timber:

- Unverified timber – No. 1 framing (as previously) visually graded to NZS 3631.
- Verified timber – No. 1 framing that has been verified in accordance with NZS 3622, now designated as VSG10, VSG8 and G8.

4.2 MACHINE STRESS GRADING

4.2.1 Machine stress grading shall be in accordance with AS/NZS 1748 except that the reference in that standard to AS/NZS 4490 shall be replaced by references to NZS 3622 and the upper level of moisture content in AS/NZS 1748 shall be 16%.

4.2.2 Grades provided for are MSG6, MSG8, MSG10, MSG12 and MSG15. Availability of some of the grades for given timber sizes is limited, and specifiers should check availability with local suppliers before finalising designs.

4.3 APPEARANCE GRADING

4.3.1 There are seven appearance grades: clean, select A, select B, dressing, merchantable, cuttings 1, cuttings 2 and box.

4.3.2 For appearance grades of timber, the primary concerns are:
- blemishes that affect the appearance, stability, machining and finishing capabilities of the finished timber
- the overall colour and figuration of the finished timber.

4.3.3 For appearance grades, NZS 3631 allows the quality of the best face and edge to determine the grade of the piece of timber. The reverse face and edge may be one grade lower.

4.4 CUTTINGS GRADE

4.4.1 Cuttings grades are used by timber processors and remanufacturers to recover shorter lengths of defect-free wood.

4.4.2 Each length of cuttings grade timber must be able to be cut into pieces of clear timber in accordance with Table 2.

4.5 BOX/MERCHANTABLE GRADES

4.5.1 Box/merchantable grades are permitted to have any number or combinations of defects provided that the piece of timber remains intact during normal handling.

4.5.2 Merchantable grade is usually sold as a separate grade with a higher value than box grade timber, such as merchantable grade decking.

5.0 DURABILITY

5.0.1 The ability of a piece of timber to meet the requirements of clause B2 *Durability* will depend on the end use defined in NZS 3602.

5.0.2 NZS 3602 includes timber species, preservative treatment, in-service moisture range and the end use environment for each building component.

5.0.3 The footnotes to Table 1 give the average natural durability ratings of 50 mm x 50 mm heartwood sample stakes in ground contact for timbers commonly used in New Zealand.

5.1 CHEMICAL TREATMENT/PRESERVATION

5.1.1 The preservative treatments used to enhance timber durability in New Zealand are detailed in NZS 3640.

5.1.2 Table 3 outlines in more detail the specifics of the chemical treatment of timber based on NZS 3602. NZS 3640 defines the chemical retention and penetration levels required for timber to achieve the durability requirements of each hazard class.

5.2 CORROSION OF FIXINGS

5.2.1 Durability of zinc protection on steel fixings can be affected by the copper in timber treatment chemicals in the presence of moisture. To avoid corrosion and to ensure the required ongoing durability of fasteners in regularly wet areas, such as critical fixings in decks, the use of stainless steel bolts, nails and connector plates is recommended. This is particularly important where the timber has been treated to hazard class H3.2 or higher (typically as high as H5 for piles) or newer ACQ and CuAZ treatments are used. For durability requirements of fasteners, refer to section 4 of NZS 3604.

5.3 UNTREATED TIMBERS

5.3.1 Where moisture content will be maintained below 18% (such as interior walls, well vented roofs, intermediate floor framing isolated from the back of the cladding by treated boundary joists and certain single-storey brick external walls), untreated kiln dried radiata pine will meet the durability requirements of NZBC clause B2.3.1. Other naturally durable species may also be used untreated for framing in these areas when there is no risk that the 18% moisture content will be exceeded during the life of the building (NZS 3602 Table 1E and clause 110).

6.0 IDENTIFYING TIMBER TREATMENT

6.0.1 The various colour codes used in the timber industry to aid identification for timber treatment may seem confusing. In reality, the colours are applied quite differently and are unique to a specific species, such as beech or pine (which are unlikely to be found together). A mandatory coloured body tint of pink is required for H1.2 boron treated framing and blue for H1.2 LOSP treated framing to differentiate the treatments. Green tinting is optional on H3.1 framing to aid identification on site and to distinguish it from other hazard classes.

6.0.2 Treated timber must also be branded (see NZS 3640 for specific requirements) with the treatment plant identification number, preservative number and hazard class (H1.1–H6). Framing timber and other dressed/gauged and treated timber will often be face branded, while rough sawn treated timber such as decking, joists and bearers will be end branded.

6.0.3 Colour tinting has been added to aid identification of framing on site, and variations in intensity of colour do not indicate the quality of the treatment or the depth of penetration.

6.0.4 Timber treated at plants certified by the New Zealand Timber Preservation Council (NZTPC) is identified by the Woodmark arrow added to the applied branding (Figure 1). All treated timber must be branded on the end or face with the plant number. Timber without the Woodmark requires separate verification for compliance.

6.0.5 Under NZS 3631, Group III timber species may be identified by end colour marking on each member to indicate its grade, but this is not mandatory (see Table 4). Group II beech species may have end-colour codes to distinguish the various species because they can all look very similar but have some significantly different properties. These are hard beech (blue), silver beech (silver) and red beech (yellow).

6.0.6 Correctly identify whether colour branding is for:
- MSG (intermittent sprayed band on face of timber)
- treatment identification (coloured body tints)
- timber grading Group III (painted end colour)
- beech species differentiation (painted end colour).

TABLE 1. TIMBER CHARACTERISTICS

SPECIES	STRENGTH[1]		DURABILITY[2]	SHRINKAGE		STABILITY	MACHINING
	Green	Dry		Radial	Tangential		
Douglas fir (NZ)	moderate	high	heart: non-durable sap: perishable	2.8	4.9	stable	poor for appearance grade timber
				dries without distorting			
Eucalypt (many varied species, some NZ grown)	high	most species very high	heart: moderate sap: susceptible to borer	no specific species data, interlocked grain may warp as drying		stable	poor
Fijian kauri	moderate	high	non-durable	2.7	4.1	very stable	excellent, splits easily when nailed
				can kiln dry from green			
Iroko	very high	very high	very durable	no data available		very stable	good, can have stone-like deposits
Jarrah	very high	very high	very durable	no data available		interlocking grain may warp when drying	good if tools in good condition
Kahikatea	moderate	high	heart: perishable sap: non-durable	2.3	4.1	stable	excellent
Kauri	moderate	high	moderately durable	2.3	4.1	very stable but splits easily	excellent
Kwila	very high	very high	heart: durable	1.2	2.6	splits unless dried slowly	blunts tools, may split with end nailing
Larch (NZ)	high	high	non-durable, resists insect attack	2.0	4.1	good but prone to twisting	may splinter and pick out knots
Lawsoniana cypress	high	high	very durable, resistant to treatment	5.0	7.0	good	excellent including turning
				dries easily			
Macrocarpa	moderate	high	heart is moderately durable, only sap can be treated	1.8	3.2	very stable but prone to cracking	very good, prone to splitting if nailed when dry
				recommend air dry			
Mahogany (Brazil)	high	high	moderately durable	low, no specific data		stable	excellent
Matai	moderate	high	non-durable	1.9	3.5	good	splits when nailed
Meranti	high	high	moderately durable	dries easily		no data	easily worked
Oak	very high	very high	durable, resists treatment, acidic, will corrode iron fixings	3.0	5.5	very good	good, drill for nails, moderate blunting
				dries slowly			
Radiata pine	moderate	moderate	non-durable, easily treated	2.1	3.9	new wood less stable	good, excellent gluing and nailing
				air or kiln dried			
Red beech	very high	very high	heart: durable, corrodes steel and galvanised steel	3.3	7.1	very stable once dry	good
				recommend slow air drying			
Redwood (imported)	moderate	moderate	durable, corrodes steel and galvanised steel	1.6	2.7	very stable, dries slowly	poor nail holding
Redwood (NZ)	moderate	moderate	heart: moderately durable sap: non-durable (treatable)	2.2	3.6	stable, prone to collapse	poor nail holding
Rimu	high	high	heart: moderately durable sap: non-durable (treatable)	3.0	4.2	very stable when dry	excellent, prone to splitting if nailed when dry
Silver beech (Southland)	very high	very high	heart: non-durable sap: moderately durable	3.1	5.7	heart: stable sap: less stable	very good
				easily dried, can kiln fry from green			
Tasmanian oak (ash eucalypt)	very high	very high	moderately durable	2.4	4.7	prone to split near pith	very good
				difficult to dry			
Tawa	high	high	non-durable	3.4	6.7	store carefully	excellent
Totara	moderate	moderate	durable	2.0	4.0	stable, brittle when dry	excellent, splits easily
				air dry only			
Vitex	high	very high	durable	1.8	4.1	good	moderately good
Western red cedar (imported)	moderate	moderate	durable, sap can be CCA treated, corrodes steel and galvanised fixings	2.4	5.0	very stable when dry	good with sharp cutters, poor nail holding
				grain collapse can occur in drying			
Western red cedar (NZ)	moderate	moderate	non-durable, sap treatable, corrodes steel and galvanised steel	2.3	4.3	not as good as imported	good with sharp cutters

1. Assessment of strength is based on:

Modulus of rupture	Megapascals (MPa)
very high	>100 MPa
high	65–100 MPa
moderate	39–64 MPa
low	<39 MPa

2. Assessment of durability is based on ground contact of 50 mm heartwood stakes:

perishable	<5 years
non-durable	5–10 years
moderately durable	10–15 years
durable	15–25 years
very durable	>25 years

GRAIN	TEXTURE	COLOUR	ACCEPTING FINISHES	COMMON END USES
straight, density variable	very coarse	sap: white heart: pink/brown	poor	structural applications, framing and sarking
slightly interlocked, ripple effect	medium to coarse, fairly open	sap: pale cream heart: dark red	polishes and paints well	flooring, finishing, veneers, furniture
straight	close, fine and uniform with ray flecking	pale cream to golden brown, undefined heart	excellent	joinery, panelling, veneers, furniture, utensils
interlocked	medium to coarse	variable, yellow to dark red/ brown	very good	veneers, furniture, flooring, joinery
interlocked and wavy	even but coarse	sap: light pinkish/red heart: pinkish to dark red	excellent with correct methods	furniture, flooring, landscaping, decking, cross arms
straight with no figuring	fine and even	sap: white heart: yellowish	good, do not use dark paints or stains externally	joinery, mouldings, veneers
straight	fine and even, silky lustrous surface	heart: light brown with slight speckle	excellent	furniture, joinery, panelling
straight or interlocked	coarse and even	sap: pale yellow heart: dark brown	good, dark leachate may affect finish	decking, poles, bridges, furniture, joinery
defined hard and soft growth rings	fine/coarse	sap: off-white heart: very pale brown	poor over hard growth ring	scaffold planks, roof battens, laminated beams
straight and even	medium/coarse	yellowish white	stains and polishes well	furniture, boat building, construction
straight (plantation grown)	fine and even	sap: white heart: yellow/brown	poor for stains	framing, joinery, weatherboards, furniture, boarding
straight or interlocked	fine and silky	heart: rich lustrous red/ brown	excellent	furniture, veneers
straight	fine and even	sap: white heart: straw	primers required, difficult to bond	joinery, flooring, furniture, finishing
interlocked, striped figure	coarse, even, some lustre	heart: dark red/brown	very good	joinery, furniture
straight	coarse, prominent growth rings	sap: white heart: yellow brown	very good	flooring, joinery
straight except for knots or pith	fine and even	sap: cream heart: pinkish	good	framing, joinery, furniture, claddings
straight	even	sap: light brown to grey heart: light red/brown	good	furniture, joinery, panelling, boat building, veneers, wharf decks
straight, close growth rings	coarse and even	sap: white heart: warm red	good except clear finishes	cladding, panelling, joinery, shingles
straight, some knots	coarse and even	sap: white heart: warm red	good except clear finishes	joinery, panelling, weatherboards
straight and figured	fine and even	sap: pale brown heart: light to dark brown	excellent except for staining	furniture, veneers, joinery, mouldings
straight with a lustre	fine and even	sap: greyish pink heart: pink to deep pink	very good	furniture, flooring, turning, finishing, panelling
straight	even and open	light straw	very good	panelling, mouldings, veneers, furniture
straight and uniform	fine	white to pale brown	excellent	furniture, turning, veneers
straight	fine and even	heart: pinkish brown	special primers required	joinery, shingles
straight to interlocked	fine, even with lustre, greasy to touch	sap: pale yellow heart: walnut brown	variable	decking, cross arms, window sills, stairs
straight and even	coarse	sap: pink heart: dark brown to salmon	very good	cladding, shingles, joinery, garden furniture
even, more knots than imported	coarse	sap: pink heart: brown to salmon	good	cladding

TABLE 2. SHORT CLEARS FROM CUTTINGS GRADE		
Minimum clear wood requirements	Cuttings grade	
	No. 1	No. 2
Minimum length for each individual piece	1.0 m	0.6 m
Total length of clears per piece	2.0 m	1.8 m
Clear cuttings as a percentage of the total length	70%	70%

7.0 MOISTURE CONTENT AND SHRINKAGE

7.0.1 Timber is hygroscopic and absorbs and releases moisture in response to changes in relative humidity of the surrounding environment. Fresh sawn timber will generally have water/moisture in the cell cavity/lumen and inside the cell wall. As the fresh timber dries, water will be lost initially from the cell cavity with the cell walls remaining wet. The point at which all cell water has dried is the fibre saturation point (FSP). Further loss of

TABLE 3. GUIDE TO TREATED TIMBER APPLICATIONS (REFER TO NZS 3602 FOR SPECIFIC APPLICATIONS AND REQUIREMENTS)

Use	Environment	Moisture content in use	H5 CCA, ACQ	H4 CCA, ACQ, CuAZ	H3.2 CCA, ACQ, CuAZ, LOSP (CuN)	H3.1 LOSP	H1.2 0.4% Boron, LOSP	H1.2 LOSP (TBTO, TBTN, IPCB/ permethrin)	H1.1 0.1% Boron, LOSP	Low-risk approved species, kiln-dried pine
Internal framing, ceiling joists and battens, internal beams[1]	Assembled under full cover, never exposed to moisture/weather, in-service use in air-conditioned or heated spaces	Less than 18%								
Roof trusses, exposed rafters and other roof framing[2]	Minimum exposure to weather during construction, dry in-service environment	Less than 18%								
Internal finishing timbers and furniture requiring borer protection[3]	Never exposed to construction moisture, in-service use in air-conditioned or heated spaces	Less than 18%							NR	NR
Framing generally, including subfloor framing, floor joists supported on external walls, skillion roof framing[4]	Exposed to construction moisture, increased risk of moisture	Less than 24% at close in, 20% in service							NR	NR
Cavity battens[5]	Possible wetting and drying						NR	NR	NR	NR
Exterior trim[6]	Exposed to weather but painted						NR	NR	NR	NR
External, cavity battens, unpainted external trim[7]	Exposed to weather or water in drained cavity but not in ground contact						NR	NR	NR	NR
Posts, retaining structures (not piles)	In contact with ground or concrete/masonry				NR	NR	NR	NR	NR	NR
Piles, poles etc.	Embedded in ground or concrete			NR	NR	NR	NR	NR	NR	NR

Notes:

1. Structural or non-structural framing members but excluding external walls and walls to wet areas. Other internal framing to platforms, ceilings, fittings etc. and inter-storey floor joists finishing behind external wall claddings must be min. H1.2 treated.
2. Roof framing members, including rafters, trusses, purlins, struts and runners that are exposed to minimal external moisture during construction (1 week or less) and will remain dry in service. Excludes skillion roof framing and rafters exposed to the exterior atmosphere, which must be min. H1.2 treated.
3. H1.1 uses are similar to zero hazard from moisture but resistance to borer is provided.
4. Standard recommended treatment for all framing timbers assembled or exposed on site during construction and for all risk categories.
5. Cladding battens where the cavity provides back-up only. H3.2 treatment required where cavity is intentionally used for drainage of water.
6. Timber exposed to the weather but primed on all faces before fixing and finished with three-coat paint system.
7. Timber exposed to rain, unpainted or with clear or stain finish.

NR = not recommended.

Colours shown in table are generally indicative of colours applied to timber with different treatments.

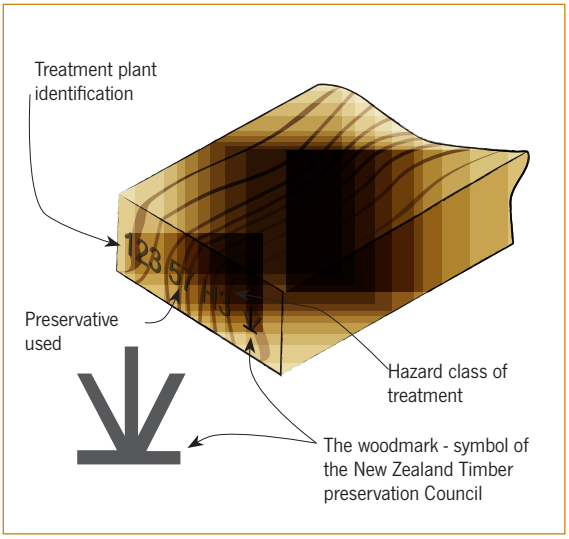

Figure 1. Branding of treated timber in New Zealand.

water from the cell walls will result in timber shrinkage. Swelling and shrinkage occurs when the cell walls absorb and release moisture (i.e. when the moisture content is below the FSP).

7.0.2 Table 5 gives the FSP for some common timber types. Note that building timbers installed when above their FSP will undergo maximum shrinkage as they dry.

7.0.3 Typical amounts of shrinkage movement from FSP to in-use moisture contents is given for 150 mm wide boards in Table 6.

7.1 MOISTURE LEVELS OF TIMBER IN USE

7.1.1 Table 7 sets out recommended maximum moisture levels for various end uses of timber. Note that some of these levels would be difficult to achieve by air drying in winter or wet weather. This has led to increased use of kiln dried timbers and preservative treatment using modern low-uptake LOSP or boron processes, which do not alter the moisture content of the dry timber and can be used on timber after it has been machined.

7.1.2 Timber delivered that has been kiln dried to below its in-use moisture content should be reconditioned to the in-use moisture content before it is fixed in place to prevent swelling after it has been installed.

TABLE 4. GROUP III SPECIES NON-MANDATORY END-COLOUR CODES

Grade	Colour
Select A	chocolate brown
Dressing	green
Merchantable	purple
No. 1 framing	black
No. 2 framing	yellow
Cutting	orange
Box	red

TABLE 5. FIBRE SATURATION POINTS FOR COMMON NZ TIMBERS

Species	FSP%
Radiata pine	29
Macrocarpa	25
Eucalyptus	30
Matai	24
Red beech	24
Tawa	30
Douglas fir	27
Redwood	25
Western red cedar	25
Kauri	26
Rimu	27
Silver beech	30
Kahikatea	28

TABLE 6. ACTUAL TIMBER SHRINKAGE

Species	Average shrinkage in mm for a 150 mm board dried from green to a moisture content of:					
	Flat sawn (tangential)			Quarter sawn (radial)		
	20%	15%	10%	20%	15%	10%
Radiata pine	2.9	4.4	5.8	1.6	2.4	3.2
Rimu	3.5	5.2	7.0	2.5	3.7	5.0
Cedar	2.5	5.0	7.4	1.3	2.6	4.0
Douglas fir	3.4	5.9	8.3	2.0	3.4	4.8

7.2 PRE-FINISHED OVERLAYS OVER DAMP SUBSTRATES

7.2.1 Pre-finished overlay flooring and wall panels are generally kiln dried before being coated and wrapped in the factory. Both panels and substrate must be conditioned to the correct in-use equilibrium moisture content before the pre-finished panelling is fixed in place to prevent it swelling in place. Refer to BRANZ Bulletin 447 *Preventing construction moisture problems in new buildings* and Bulletin 515 *Measuring moisture in timber and concrete*.

TABLE 7. MAXIMUM RECOMMENDED PERCENTAGE MOISTURE CONTENT WHEN FIXED

Timber use	Measured when	Centrally heated building	Irregularly heated building[1]	Non-heated building
Weatherboards, exterior joinery, exterior finishing timbers	fixed in place	14–18	14–18	14–18
Ground level suspended floor framing	floor laid	8–14	12–16	14–18
Interior joinery, trims, furniture, flooring[2]	fixed in place	8–12	10–14	12–16
All framing above ground floor level	fixing linings[3]	8–16	12–16	12–16
Roof trusses, lintels, beams, floor joists deeper than 200 mm	erected	8–16	12–16[4]	12–16[4]

Notes: Installers must make sensible allowances for site and climatic conditions to avoid timber movement that will be detrimental to the required finishing allowances. In BRANZ's experience, these recommended moisture contents (copied from NZS 3602) are, in practice, often too high, resulting in significant additional shrinkage. It is recommended therefore that users err at the lower end of the recommendation rather that at the high end.

1. Buildings heated by open fires, solid fuel burners or portable heaters.
2. Pre-finished overlay flooring is very critical and requires on-site conditioning and dry substrates (see BRANZ Bulletins 447, 506 and 513).
3. NZS 3602 specifies a maximum moisture content of 20% prior to the application of internal linings and finishing timbers, while some gypsum plasterboard manufacturers require less than 20% before fixing their products.
4. Lintels, beams and upper floor joists may require propping until recommended equilibrium moisture content is reached.

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