NelsonPine Laminated Veneer Lumber LVL

SPECIFIC ENGINEERING DESIGN GUIDE

LIMIT STATE DESIGN

CHARACTERISTIC

PROPERTIES AND

STRUCTURAL DESIGN

INFORMATION

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Introduction to NelsonPine LVL

NelsonPine LVL is an engineered wood composite made from rotary peeled veneers, laid up with parallel grain orientation. One of the main features of LVL is to disperse or remove strength-reducing characteristics of wood. NelsonPine LVL is an engineered, highly predictable, uniform lumber product, because natural defects such as knots, slope of grain and splits have been dispersed throughout the veneer assembly or have been removed altogether. In addition to this, the veneer sheets are placed in a specific sequence and location within the product to maximise the potential of the stiffer and stronger veneer grades. This can be considered as an engineered configuration of the veneers. NelsonPine LVL is dimensionally stable, resists warping and twisting and is machined to consistently uniform sizes.

Manufacture

NelsonPine LVL is manufactured by laminating ultrasonically graded Radiata Pine veneer sheets, using phenolic adhesive, in a continuous assembly in which the grain direction of the veneers are orientated in the longitudinal direction. In some instances, cross band veneers may be introduced. Using highly sophisticated continuous belt pressing technology and microwave pre-heating, it is pressed as a 1.220m nominal width continuous billet in various standard thicknesses. It can be docked to any specified length and ripped into standard widths for use as structural members.

Environmental Impacts

NelsonPine LVL is produced in a high-technology mill which has strict environmental controls on amenity features and emission levels. Burning of wood waste generated in veneer preparation and billet processing provides most of the on-site heating resulting in a major reduction in CO_2 emissions compared with burning fossil fuels, and makes NelsonPine LVL manufacturing greenhouse neutral.

Timber construction has been internationally accepted as an "environmentally responsible" choice, when compared to alternative materials such as steel, concrete or aluminium. This can be demonstrated from a life cycle analysis, including the impacts of material extraction, manufacture, construction, use and disposal. In addition, the technological base of manufacture ensures that NelsonPine LVL is a more efficient use of wood fibre, with less waste than sawn timber.

Branding of NelsonPine LVL

NelsonPine LVL is branded with the product manufacturer's logo and JAS-ANZ accredited EWPAA product certification mark.

NelsonPine Laminated Veneer Lumber LVL

PRODUCT CERTIFIED paa ENGINEERED WOOD

Surface Appearance

Because NelsonPine LVL is a natural product the face veneers may contain minor blemishes such as knots, small knot holes, scarf joints or glue marks. The surface may be planed or sanded and left unfinished, painted or stained.

It should be noted that a sanded or planed surface makes the product more susceptible to surface swelling and cracking due to lathe checks becoming exposed in the outer veneer. Exposure to weather for long periods of time can result in swelling and discolouration.

Product Specification

Veneer

Thickness	2.5 - 4.4mm
Species	Radiata Pine
Joints	Scarf / Overlap / Butt

Moisture Content:
8 - 15% ex mill

Adhesive:
Phenolic adhesive (AS 2754.1) producing a Type A marine bond (AS/NZS 2098.2)

Formaldehyde Emission Class:
E_0 (Table 1 AS/NZS 4357.0)

Nominal Tolerances:

Depth:	-2, +2mm
Thickness:	-2, +2mm

Storage and Handling

NelsonPine LVL expands in thickness and depth when allowed to get wet. To ensure the full benefits of NelsonPine LVL as a dry, straight and true material are available at the time of installation, the following recommendations regarding storage are made:

1. Stack on evenly spaced level bearers to keep flat and straight
2. Stack well clear of the ground for good ventilation
3. Store under cover to keep dry prior to installation
4. Take care to re-wrap remaining material after opening
5. Use 100 x 50mm bearers on the flat between bundles

NelsonPine LVL Limit State Design Characteristic Properties

Structural Reliability

The structural properties for NelsonPine LVL13 and NelsonPine LVL11 in Tables 1 - 4 have been determined by testing in accordance with the requirements of AS/NZS 4357.0:2005 Structural Laminated Veneer Lumber and the characteristic stresses have been calculated in accordance with AS/NZS 4063.2:2010.

NelsonPine LVL characteristic stresses comply with the New Zealand building code through clause C2.3 in NZS 3603:1993. The modulus of elasticity is an average value which includes an allowance for shear deformation. Because of the low variability a lower bound MoE is not required.

Table 1. NelsonPine LVL13 Limit State Design Characteristic Values

Property		Edge (MPa)	Flat (MPa)
Modulus of Elasticity	MoE	13200	13200
Modulus of Rigidity	G	660	660
Bending Strength[1]	f'b	48.0	48.0
Tension Parallel to Grain[2]	f't	33.0	33.0
Compression Parallel to Grain	f'c	38.0	38.0
Shear in Beams	f's	5.3	3.0
Compression Perpendicular to Grain	f'p	10.0	12.0

[1] for 95mm in depth. Refer to Table 8 for adjustment factor above 95mm depth
[2] for 150mm in depth. Refer to Table 8 for adjustment factor above 150mm depth

Table 2. NelsonPine LVL13 Section Sizes and Design Properties

Section Size (mm)	Mass (kg/m)	I_{xx} (10^6mm^4)	EI_x (10^9Nmm^2)	Z_{xx} (10^3mm^3)	Ø f'bZ_x (kNm)#
150 x 45	3.8	12.7	167	169	6.8
170 x 45	4.4	18.4	243	217	8.5
200 x 45	5.1	30.0	396	300	11.4
240 x 45	6.2	51.8	684	432	16.0
300 x 45	7.7	101.3	1337	675	24.1
360 x 45	9.2	175.0	2309	972	33.6
400 x 45	10.3	240.0	3168	1200	40.8
150 x 63	5.4	17.7	234	236	9.5
200 x 63	7.2	42.0	554	420	16.0
240 x 63	8.6	72.6	958	605	22.4
300 x 63	10.8	141.8	1871	945	33.7
360 x 63	12.9	244.9	3233	1361	47.1
400 x 63	14.4	336.0	4435	1680	57.1

#Ø =0.9 for Category 2 applications (refer to Table 5. Strength Reduction Factors)
Calculation includes the k_{24} Size Factor

Non Standard Grades and Sizes

Nelson Pine Industries Ltd also manufactures other LVL grades and crossbanded LVL products for targeted applications. NelsonPine LVL can be manufactured in sections up to 18.4m in length and 1220mm in width and 12-90mm in thickness.

Table 3. NelsonPine LVL 11 Limit State Design Characteristic Values

Property		Edge (MPa)	Flat (MPa)
Modulus of Elasticity	MoE	11000	11000
Modulus of Rigidity	G	550	550
Bending Strength[1]	f'b	38.0	38.0
Tension Parallel to Grain[2]	f't	26.0	26.0
Compression Parallel to Grain	f'c	38.0	38.0
Shear in Beams	f's	5.0	3.0
Compression Perpendicular to Grain	f'p	10.0	10.0

[1] for 95mm in depth. Refer to Table 8 for adjustment factor above 95mm depth
[2] for 150mm in depth. Refer to Table 8 for adjustment factor above 150mm depth

Table 4. NelsonPine LVL11 Section Sizes and Design Properties

Section Size (mm)	Mass (kg/m)	I_{xx} (10^6mm^4)	EI_x (10^9Nmm^2)	Z_{xx} (10^3mm^3)	Ø f'bZ_x (kNm)[#]
90 x 45	2.3	2.7	30	61	2.1
115 x 45	2.9	5.7	63	99	3.3
140 x 45	3.6	10.3	113	147	4.7
190 x 45	4.9	25.7	283	271	8.2
240 x 45	6.2	51.8	570	432	12.7
300 x 45	7.7	101.3	1114	675	19.1
360 x 45	9.2	175.0	1925	972	26.6
400 x 45	10.3	240.0	2640	1200	32.3
610 x 45	15.6	851.2	9363	2791	70.0
1220 x 45	31.3	6809.4	74904	11163	249.3
150 x 90	7.7	25.3	278	338	10.7
200 x 90	10.3	60.0	660	600	18.1
240 x 90	12.3	103.7	1140	864	25.3
300 x 90	15.4	202.5	2228	1350	38.1
360 x 90	18.5	349.9	3849	1944	53.2
400 x 90	20.5	480.0	5280	2400	64.6
610 x 90	31.3	1702.4	18726	5582	139.9
1220 x 90	62.6	13618.9	149807	22326	498.5

[#]Ø =0.9 for Category 2 applications (refer to Table 5. Strength Reduction Factors)
Calculation includes the k_{24} Size Factor

NelsonPine LVL Structural Design Information

Design Standards

Design loads are to be determined in accordance with AS/NZS 1170:2002. Although design data for NelsonPine LVL is not specifically given in NZS 3603:1993, the general principles can be used, complying with the New Zealand Building Code through Clauses 2.3 and C2.3 of NZS 3603. For specific design in Australia this section is to be read in conjunction with AS1720.1

Strength Modification Factors

Because of the low variability in properties of NelsonPine LVL, a number of the k factors do not apply or are different from those in NZS 3603. The strength modification factors for NelsonPine LVL are:

1. Strength Reduction Factor

The strength reduction factor for calculating the design of structural members should be taken from Table 5.

Table 5. Strength Reduction Factors

Table extracted from Table 2.1 AS1720.1-2010

	Category 1	Category 2	Category 3
Structural Timber Material	Structural members for houses for which failure would be unlikely to affect an area* greater than $25m^2$: OR secondary members in structures other than houses	Primary structural members in structures other than houses: OR elements in houses for which failure would be likely to affect an area* greater than $25m^3$	Primary structural members in structures intended to fulfill an essential service or post disaster function
Stuctural Laminated Veneer Lumber - AS/NZS 4357.0	0.95	0.90	0.80

* In this context, area should be taken as the plan area.

2. Duration of Load Factors

Duration of load factors k_1 for strength and k_2 for stiffness should be the same as for solid timber in Tables 2.4 and 2.5 of NZS 3603. NelsonPine LVL is a solid veneer product and has similar load duration properties to timber. It is manufactured in the dry condition so will behave like kiln dried solid sawn timber, except that moisture change will be slower because the glue lines provide a barrier to moisture movement.

3. Bearing Area Factor

The bearing area k_3 is per NZS 3603.

4. Load sharing factor

Because NelsonPine LVL is much less variable than sawn lumber, the load sharing and lamination relationships in NZS 3603 do not apply. Hence, $k_4 = k_5 = k_6 = 1.0$.

5. Moisture Content Factor

For use of NelsonPine LVL in dry conditions, no modification is required. Where NelsonPine LVL is subject to humid conditions such that the average moisture content would exceed 16% over a 12 month period, the moisture content factor k_{14} in Table 6 should be used for strength calculations. A moisture content exceeding 20% may be subject to a decay hazard, requiring chemical treatment of the NelsonPine LVL or detailing to avoid the high moisture content.

NelsonPine LVL responds to moisture a similar way as solid wood, albeit slower as the gluelines inhibit moisture uptake.

Table 6. Moisture Content Factor k_{14}

Property	Moisture Content (MC) <16%	16 to 25%	>25%
Bending and Compression	1.0	1.53 - 0.033 MC	0.7
Tension and Shear	1.0	1.35 - 0.022 MC	0.8
Modulus of Elasticity	1.0	1.35 - 0.022 MC	0.8

6. Stability Factor

The stability factor k_8 is per NZS 3603.

7. Face Grain Orientation (Curved or Tapered edges)

LVL is made from parallel laminated veneer. It is very strong parallel to the grain, but stresses perpendicular to the grain should be avoided, just as in solid timber. Wide sections must be handled carefully.

When a design includes principal stresses parallel to edges which have been cut sloped or curved to the longitudinal grain direction (Figure 1), the grain orientation factor k_{16} for strength given in Table 7 should be used to evaluate strength reduction at the extreme fibre edges. Examples where this might be considered are at the point of highest bending moment in a sloping rafter or column edge, such as at a knee or apex joint in a portal frame. Steep grain slopes should be avoided if possible in tension zones because the strength reduction is severe.

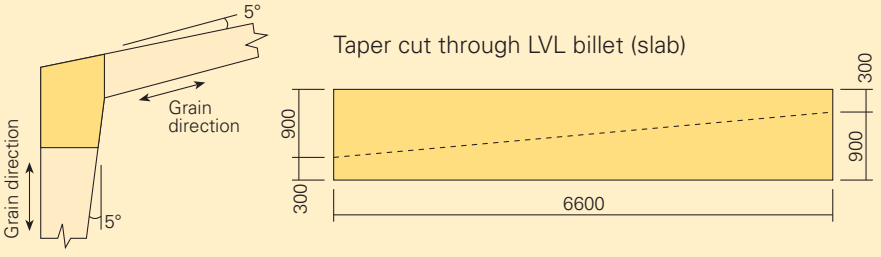
To determine bending deflections k_{16}, the stiffness of sloping sections can be evaluated by integrating (summing) a number of small lengths of changing section depth.

Table 7. Grain Orientation Factor k_{15} and k_{16} for Cut Edges

Angle of Cut Edge (°)	0	3	5	10	15	20	30	45
Edge in Tension	1.00	0.92	0.80	0.50	0.31	0.21	0.11	0.06
Edge in Compression	1.00	0.97	0.93	0.79	0.65	0.55	0.42	0.32

Figure 1. An Example of Design for Sloping Grain in NelsonPine LVL

The taper cut rafter has taper cut through LVL billet (slab) high tensile stress at 5° cut, so use k_{15} = 0.8.
The column cut from the same slab has cut edge in compression, so use k_{15} = 0.93.



8. Size Effect Factor

A size factor shall be applied to the characteristic strength of NelsonPine LVL in bending and tension parallel to grain as per Table 8. For beams in bending less than 95mm in depth there is no adjustment. For beams deeper than 95mm in bending multiply the characteristic bending strength by $(95/d)^{0.167}$. For beams in tension less than 150mm in depth there is no adjustment. For beams deeper than 150mm multiply the characteristic tension strength by $(150/d)^{0.167}$.

Table 8. Size Factor k_{24} for Bending and Tension Strength (Parallel to Grain) in NelsonPine LVL

	Depth of LVL member (mm) 95	150	200	240	300	360	400	460	610	1220
Bending	1.00	0.93	0.88	0.86	0.83	0.80	0.79	0.77	0.73	0.65
Tension	1.00	1.00	0.95	0.92	0.89	0.86	0.85	0.83	0.79	0.70

For shear and compression the size factor = 1.0
For tension perpendicular to grain, refer to AS 1720.1

9. Joint Group

The Joint Strength Group for NelsonPine LVL depends on the orientation and type of fasteners as per Table 9. For structures that require specific design of joints, this table is to be read in conjunction with NZS3603 Section 4, Joints.

Table 9. Classification of NelsonPine LVL for Joint Design

Grade	Nails and screws in Lateral Load		Nails and screws in Withdrawal		Self Drilling screws in Lateral Load (e.g. Type 17)		Self Drilling screws in Withdrawal (e.g. Type 17)		Bolts and coach screws in Lateral load drilled into the face	
	Edge	Face	Edge	Face	Edge	Face	Edge	Face	Edge	Face
LVL13	J5	J4	J5	J4	J4		J4/5		J3	J2
LVL11	J5	J4	J5	J4					J3	J2

Fasteners in the Face = fasteners that penetrate the face perpendicular to the grain
Fasteners in the Edge = fasteners that penetrate the edge parallel to the glue lines

10. Fire Resistance

Large NelsonPine LVL members have excellent fire resistance on account of the slow and predictable charring rate when exposed to severe fires. The phenol formaldehyde adhesive used in the manufacture of NelsonPine LVL remains inert during fire exposure. NelsonPine LVL can be designed for fire resistance in the same way as glulam. From studies completed at the University of Canterbury, the design charring rate of NelsonPine LVL in the standard fire test has been shown to be 0.72mm/min.

11. Durability of NelsonPine LVL

The durability of NelsonPine LVL is related to the durability of its two comprising components; the structural adhesive and the Radiata Pine veneers.

The dark brown Phenol Formaldehyde thermosetting adhesive that is used in the manufacture of NelsonPine LVL produces a Type A-bond. A Type A-bond is durable and permanent under conditions of full weather exposure, long term stress, and combinations of exposure and stress. When Phenol Formaldehyde is cured under heat and pressure it forms a highly extended irreversible cross linked web of covalent bonds. It is this irreversible crosslinked nature of phenolics which gives them their hardness, good thermal stability and makes them impervious to most chemical attack and solvation. Formaldehyde-based resins have been well proven and documented as an adhesive in the wood industry for over 70 years. The adhesive bond is regularly sampled in the manufacturing process under the third party quality assurance program carried out by the Engineered Wood Products Association of Australasia (EWPAA).

The Radiata Pine veneers used in the manufacture of NelsonPine LVL may be treated or untreated depending on the level of durability required. NelsonPine LVL may be treated in accordance with AS/NZS 1604.4:2010 Specification for Preservative Treatment – Laminated Veneer Lumber.

New Zealand Building Code

Durability is covered in the New Zealand Building code (NZBC) in Section B2 – Durability and Section E2 – External Moisture. The durability clause requires that materials, components and construction methods allow the building to function for its specified intended life of not less than 50 years for structural and inaccessible elements. An acceptable solution to the building code is referenced in B2/AS1 where the New Zealand standards NZS 3604 and NZS 3602 specify the level of treatment and the application respectively. Alternative solutions may be accepted by Territorial Authorities if the solution meets the durability requirements of the Building Code.

Internal Use of NelsonPine LVL

In internal dry conditions where the equilibrium moisture content of wood will be below 20%, NelsonPine LVL may be used untreated to meet the NZBC requirements of 50 years of durability. Fungal growth which can lead to rot or decay in timber will not be able to germinate and develop unless there is a continual supply of moisture (>20% moisture content). NelsonPine LVL can withstand wetting during construction provided the product can return to equilibrium moisture content below 20% for the remainder of its service life. Where the appearance of NelsonPine LVL is critical it should be protected from extended periods of wetting before construction to avoid staining and potentially the initial stages of mould growth. The surface veneers of NelsonPine LVL will respond quickly to cycles of wetting and drying to form surface cracks if exposed to the weather for extended periods.

12. Corrosion Resistance

Radiata Pine is relatively inert chemically and under normal conditions, unlike other structural materials it is not subject to chemical change or deterioration. NelsonPine LVL is resistant to most acids, rust and other corrosive situations including hide curing complexes, fertiliser storage and swimming pools.

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Laminated Veneer Lumber LVL

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PRODUCT CERTIFIED paa ENGINEERED WOOD

Telarc. Registered Quality ISO 9001

Telarc. Registered Environment ISO 14001

Plantation Grown. All veneers used in the manufacture of NelsonPine LVL are peeled from sustainable plantation grown Pinus Radiata logs.

PLANTATION GROWN • RENEWABLE RESOURCE •