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Next generation biomaterials

Results

To:	Dean Satchell	**From:**	Bruce Davy
Organisation:	Farm Forestry Timbers Society C/- New Zealand Farm Forestry Association	**Subject:**	Macrocarpa Ingrade test results
Location:	P.O.Box 10349 the Terrace, Wellington 6143	**Date:**	18 December 2014
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Dean,

With reference to the 100x50 Macrocarpa timber supplied by two producers, Lumber Processors and Laurie Forestry for in-grade testing.

The timber was visually graded to the Farm Forestry Timbers No. 1 Structural grade, as follows: http://www.nzffa.org.nz/specialty-timber-market/brand-grades/structural-grading/

Appendix F lists these visual grade rules.

Timber Testing

The timber was tested for bending strength and stiffness as a joist, Tension strength Compression Strength and Shear Strength in accordance with AS/NZS4063.1:2010.

All the testing was undertaken in our Grade 1 Baldwin Universal test machine with the exception of the tension strength testing which was done in the tension testing machine.

The strength testing was completed in the Timber Engineering laboratory of Scion, Rotorua, New Zealand.

Strength and Stiffness Test Results

The characteristic strength and stiffness properties have been calculated using the calculations and procedures set out in AS/NZS4063.2:2010.
The following Tables 1 & 2 show the statistical test data of the timber from the two sources.
Table 3 shows the characteristic strength and stiffness values for the combined sample of Macrocarpa timber along with a statistical summary.
Table 4 lists the New Zealand characteristic grade stresses for the SG visual grades

Appendix's A to E list the raw test data collected.

Table 1: *Bending Strength and Stiffness properties - ex Laurie Forestry*

	100 x 50 Macrocarpa – ex Laurie Forestry				
	Bending Stiffness MoEj (GPa)	**Bending Strength MoRj (MPa)**	**Tension Strength (MPa)**	**Shear Strength (MPa)**	**Compression Strength (MPa)**
Mean	5.95	29.57	13.50	3.94	27.27
Minimum	4.73	14.80	5.31	2.59	20.71
Maximum	8.58	51.35	23.86	4.87	36.47
Range	3.85	36.55	18.54	2.28	15.76
Standard Deviation	1.15	10.19	4.99	0.76	3.64
Coefficient of Variation	19.30%	34.46%	36.99%	19.24%	13.36%
Count	17	17	14	16	30

Table 2: *Bending Strength and Stiffness properties – ex Lumber Processing*

	100 x 50 Macrocarpa – ex Lumber Processing				
	Bending Stiffness MoEj (GPa)	**Bending Strength MoRj (MPa)**	**Tension Strength (MPa)**	**Shear Strength (MPa)**	**Compression Strength (MPa)**
Mean	8.82	38.19	18.86	4.52	35.13
Minimum	6.07	17.01	3.88	1.98	21.99
Maximum	12.16	55.09	35.66	6.31	48.56
Range	6.09	38.08	31.79	4.33	26.57
Standard Deviation	1.78	10.83	7.82	1.22	6.78
Coefficient of Variation	20.13%	28.36%	41.47%	27.10%	19.30%
Count	13	13	15	14	30

Table 3: *Bending Strength and Stiffness properties – Combined*

Combined Macrocarpa – ex Laurie Forestry & ex Lumber Processing					
	Bending Stiffness MoEj (GPa)	**Bending Strength MoRj (MPa)**	**Tension Strength (MPa)**	**Shear Strength (MPa)**	**Compression Strength (MPa)**
Mean	7.19	33.31	16.27	4.21	31.20
Minimum	4.73	14.80	3.88	1.98	20.71
Maximum	12.16	55.09	35.66	6.31	48.56
Range	7.43	40.29	31.79	4.33	27.85
Standard Deviation	2.03	11.17	7.04	1.03	6.69
Coefficient of Variation	28.26%	33.53%	43.28%	24.39%	21.46%
Count	30	30	29	30	60
Characteristic Strength (MPa)		**16.09**	**5.76**	**2.67**	**23.90**
Characteristic Stiffness (GPa)	**6.08**				
Assigned Grade	**SG 6**	**SG 8**	**SG 6**	**Reject**	**SG 10**

Table 4: *Characteristic stresses for SG graded timber NZS3603 A4*

1. Moisture Content – Dry (m/c = 16%)					
Radiata pine and Douglas Fir	**Bending Strength MPa**	**Compression Strength MPa**	**Tension Strength MPa**	**Bending Stiffness GPa**	**Lower bound Bending Stiffness GPa**
SG10 (Dry)	20.0	20.0	8.0	10.0	6.7
SG8 (Dry)	14.0	18.0	6.0	8.0	5.6
SG 6 (Dry)	10.0	16.0	4.0	6.0	4.0
Verified Heartland	14	16	4.0	6.0	4.0
2. Moisture Content – Green (m/c = 25%)					
SG 10 (Wet)	15	14.0	5.0	8.0	5.6
SG 8 (Wet)	11.7	12.0	4.0	6.5	4.4
SG 6 (Wet)	7.5	11.0	3.0	4.8	3.2

Note:

- The shear strength for dry Radiata pine, (all grades) shall be taken as fs = 3.8 MPa.

References

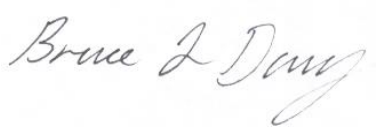
1. AS/NZS4063.1:2010, Characterization of structural timber Part 1: Test methods. Standards Australia/Standards New Zealand.
2. AS/NZS4063.2:2010, Characterization of structural timber Part 1: Determination of characteristic values. Standards Australia/Standards New Zealand.

Summary

Comparing Tables 1 & 2 shows the:

- The material supplied by Lumber Processing appeared to have, on average better structural properties
- This sample of macrocarpa failed to achieve the required structural properties for bending stiffness and shear, for SG6 grade.

I trust this initial information meets with your approval, please feel free to contact me if you have any queries



Bruce Davy

Appendix A: *Bending Test data for the Nelson Redwood*

Lab No.	Client ID.	Width (mm)	Depth (mm)	MoEj (GPa)	MoRj (MPa)
271780	Laurie Forestry	53.69	102.46	5.64	32.79
271781	Laurie Forestry	51.01	99.48	4.82	26.44
271783	Laurie Forestry	50.17	99.72	5.70	24.76
271785	Laurie Forestry	50.78	100.47	4.73	29.45
271788	Laurie Forestry	54.40	104.32	6.21	40.03
271790	Laurie Forestry	50.16	101.25	7.61	43.85
271792	Laurie Forestry	50.10	100.16	6.63	24.61
271793	Laurie Forestry	46.60	103.67	4.76	27.19
271795	Laurie Forestry	49.30	100.81	7.40	35.01
271797	Laurie Forestry	51.82	101.94	8.58	51.35
271798	Laurie Forestry	51.45	101.43	4.73	16.11
271799	Laurie Forestry	50.67	101.44	5.92	20.34
271803	Laurie Forestry	50.30	99.16	6.27	33.70
271805	Laurie Forestry	49.99	101.26	4.88	26.24
271806	Laurie Forestry	50.78	100.88	5.81	16.77
271807	Laurie Forestry	50.11	100.62	6.57	39.24
271808	Laurie Forestry	49.98	102.39	4.82	14.80
271779	Lumber Processors	50.70	98.24	9.84	40.83
271782	Lumber Processors	52.10	98.68	12.16	36.39
271784	Lumber Processors	49.07	98.49	10.68	55.09
271786	Lumber Processors	52.57	98.75	8.34	39.50
271787	Lumber Processors	52.24	97.17	8.14	17.01
271789	Lumber Processors	49.47	101.37	6.07	31.39
271791	Lumber Processors	51.46	98.54	10.94	52.63
271794	Lumber Processors	51.02	97.62	8.82	34.32
271796	Lumber Processors	50.07	100.25	9.35	39.95
271800	Lumber Processors	51.19	99.87	6.23	44.77
271801	Lumber Processors	51.41	99.50	7.62	30.70
271802	Lumber Processors	51.71	97.76	7.84	24.98
271804	Lumber Processors	52.68	98.16	8.65	48.93

Appendix C: *Compression Parallel Test data*

Laurie Forestry			
Lab No.	**Width (mm)**	**Depth (mm)**	**Comp'n Stress (MPa)**
271810	50.62	100.94	27.99
271811	49.25	98.65	25.52
271812	49.09	98.49	27.94
271813	50.29	100.06	23.92
271814	48.74	99.36	20.71
271815	49.75	101.23	25.81
271816	50.89	100.85	27.60
271817	49.29	100.91	25.32
271818	52.06	100.03	26.48
271819	50.27	100.43	22.12
271820	50.62	100.13	24.67
271821	49.85	98.96	32.36
271822	51.54	101.20	31.24
271823	49.59	100.10	23.91
271824	51.46	100.97	25.87
271825	49.86	101.37	28.59
271826	50.69	100.70	31.59
271827	47.31	101.22	25.05
271828	50.54	102.35	30.62
271829	51.37	100.66	30.66
271830	50.58	98.69	27.71
271831	49.33	99.96	22.78
271832	50.83	100.49	24.16
271833	49.47	100.42	27.95
271834	50.51	100.33	22.70
271835	52.89	102.84	25.67
271836	49.90	100.19	32.85
271837	51.04	99.97	36.47
271838	50.08	100.22	30.11

Lumber Processors			
Lab No.	**Width (mm)**	**Depth (mm)**	**Comp'n Stress (MPa)**
271809	53.60	101.11	29.65
271839	52.65	102.31	48.56
271840	50.10	97.82	38.63
271841	51.77	97.12	32.37
271842	51.40	98.86	44.96
271843	50.01	100.16	41.44
271844	51.93	96.46	29.61
271845	48.42	99.47	23.06
271846	52.23	103.86	30.55
271847	51.53	98.63	33.05
271848	51.03	97.47	34.01
271849	52.05	94.93	30.45
271850	52.34	100.93	31.17
271851	48.59	100.20	24.82
271852	51.23	96.86	37.79
271853	52.85	100.61	36.76
271854	51.03	97.11	31.86
271855	53.23	102.33	46.37
271856	48.17	97.56	39.84
271857	53.48	103.46	33.53
271858	50.85	98.03	22.36
271859	52.17	99.68	35.44
271860	51.07	99.74	37.70
271861	50.59	95.85	39.27
271862	51.13	97.53	41.59
271863	51.02	98.32	41.13
271864	50.65	97.50	36.89
271865	50.71	99.15	32.53
271866	52.44	99.38	35.38
271867	52.47	100.34	40.65
271868	50.89	97.61	21.99

Appendix D: *Tension Test data for the Redwood*

Lumber Processors			
Lab No.	**Width (mm)**	**Depth (mm)**	**Tensile Stress (MPa)**
271869	52.13	103.62	15.62
271870	51.53	98.49	15.62
271871	52.41	98.09	26.78
271872	51.86	98.85	9.28
271873	51.18	93.78	3.88
271874	53.49	101.73	20.39
271875	52.84	100.72	27.40
271876	51.36	99.50	15.76
271877	53.50	101.97	13.38
271878	49.96	100.51	14.51
271879	55.48	100.79	19.74
271880	52.33	102.18	19.17
271881	52.38	102.30	20.88
271882	53.75	100.74	24.77
271883	52.81	102.02	35.66

Laurie Forestry			
Lab No.	**Width (mm)**	**Depth (mm)**	**Tensile Stress (MPa)**
271884	51.48	100.69	13.35
271885	50.05	100.07	16.58
271886	50.18	98.65	9.77
271887	50.61	99.47	18.17
271888	50.09	100.06	12.07
271889	50.13	101.47	15.42
271890	51.89	100.07	12.48
271891	50.52	100.63	11.18
271892	51.87	99.19	10.82
271893	51.71	100.09	20.86
271894	50.29	99.86	23.86
271895	49.96	101.36	9.76
271896	51.45	102.85	5.31
271897	51.04	99.97	9.37
271884	51.48	100.69	13.35

Appendix E: *Shear Test data for the 100x50 Totara*

Lumber Processors			
Lab No.	**Width (mm)**	**Depth (mm)**	**Shear Stress (MPa)**
271899	52.05	101.23	4.65
271900	48.74	97.20	6.31
271901	52.72	99.99	5.44
271902	52.79	97.80	5.00
271903	51.23	96.72	2.48
271904	50.48	99.63	4.77
271905	50.08	95.14	1.98
271906	51.47	96.74	4.61
271907	52.73	95.21	4.81
271908	51.56	99.64	6.26
271909	54.43	100.97	4.24
271910	50.53	94.59	3.66
271911	49.85	100.25	3.98
271912	52.29	101.14	5.05

Laurie Forestry			
Lab No.	**Width (mm)**	**Depth (mm)**	**Shear Stress (MPa)**
271913	51.69	99.97	4.77
271914	51.63	101.28	4.18
271915	51.41	100.54	4.19
271916	49.77	98.64	2.64
271917	48.16	100.87	4.49
271918	50.37	102.40	3.68
271919	50.16	99.21	4.30
271920	51.80	102.62	3.64
271921	49.66	100.84	4.87
271922	50.14	99.82	3.83
271923	50.57	100.07	2.59
271924	52.52	101.10	4.59
271925	50.82	101.86	4.71
271926	50.31	101.86	2.61
271927	49.59	99.72	4.15
271928	47.07	100.64	3.83

Appendix F: No. 1 structural grade rules

(As supplied by Dean Satchell Email 11 April 2013)

Distortion

- Bow maximum 40/1
- Crook maximum 200/1
- Twist minimal
- Cup 75/1

Knots, holes, voids, bark-inclusion, bark-pockets, resin pockets, pith, decay, wane, sloping grain greater than 1/10 (including sloping grain surrounding spike knots [Sloping grain surrounding spoke knots, being a serious weakness causing defect, must be taken into account when determining the cross section of a spike knot.]) and other weakness-causing defect:

- Not more than 1/3 of cross section in combination up to 150 mm board;
- Not more than 1/4 of cross section in combination for larger than 150 mm board.

No voids ["Voids" include holes, bark-pockets, resin pockets and bark inclusion] longer than the width of the face of the piece. Where bark inclusion and associated voids do not exceed 5% of the cross section the length is not restricted.

Checks, collapse and pith are not restricted.

Pith includes surrounding wood to a radius of 10 mm.

Wane and skip are to be kept to a minimum. No more than 5% of cross section.

Splits not allowed. Shakes not allowed.

Maximum sloping grain: 1 in 10

Spike knots:
The length of the longest edge [As seen on the face of the piece and where adjacent sloping grain is greater than 1 in 10] of a spike knot must not be greater than 75% of the width of the face of the piece. Where structural members are of square cross section this does not apply.

Sapwood shall be treated to h1.2.