Specialty Wood Products Research Partnership

SCION FORESTS ▪ PRODUCTS ▪ INNOVATION

Recalculation of Ovensii Bending Strength and Stiffness

Authors: Doug Gaunt, Bruce Davy

Date: 12th October 2022

Publication No: SWP-T154

FOREST GROWERS RESEARCH

TABLE OF CONTENTS

FOREST GROWERS RESEARCH

EXECUTIVE SUMMARY

In terms of bending stiffness, the *C. ovensii* achieved the SG6 structural grade, in terms of bending strength, the *C. ovensii* achieved the SG12 structural grade resulting in an overall grade of SG6.

To assign a full structural grade the other strength properties tension, compression and shear need to be evaluated.

INTRODUCTION

The original timber came from the 2019-2020 cypress sawing study, some this timber was incorrectly supplied and or labelled (i.e., it was not *C. ovensii*). An additional 5 pieces of *C. ovensii* were supplied by Dean Satchell

Combining these data sets enabled the determination of characteristic design properties. It needs to be noted that these properties may or may not be appropriate for all cypress grown in New Zealand when we consider different sites, different genetics different silviculture, and different rotation ages.

Ideally to determine characteristic properties we need to test full dimension timber, covering a range of structural sizes in bending, tension, compression and shear. This would require a large volume of timber and for tension testing long lengths. However, 90% of the span tables in NZS3604 are governed by bending strength and stiffness., Tension and compression strength is required in trusses, Shear strength can be important in short span heavily lintels and bearers.

It was therefore suggested as a start that only bending strength and stiffness is assessed.

Objective

- To determine the characteristic bending strength and stiffness design stresses for *C. ovensii*.

TIMBER SELECTION

Characteristic bending testing

Ruapehu Sawmills supplied Scion with 49 pieces of rough-sawn 100x50mm *C. ovensii* in good faith. Dye testing of the heartwood after timber evaluation was complete found that some of the test boards were not *C. ovensii*. At some point, between tree felling and species checking, there was a mislabelling or mix-up of boards. There was no negligence on anyone's part, but the result was that the initial set were subsequently resorted to find 25 pieces of *C. ovensii*.

A further 5 pieces of rough-sawn 100x50mm of *C. ovensii* were supplied by Dean Satchell

These samples have been combined to produce a 30 piece data set.

CHARACTERISTIC TIMBER TESTING

Bending Strength and Stiffness Test Results

The 100x50 timber was tested for bending strength and stiffness as a joist, in accordance with AS/NZS4063.1:2010 with the testing being undertaken in our Grade-1 Baldwin Universal test machine in the Timber Engineering laboratory of Scion, Rotorua, New Zealand.

The characteristic strength and stiffness properties have been calculated using the calculations and procedures set out in AS/NZS4063.2:2010.

The following Table 1 shows the characteristic strength and stiffness values for the No 1Framing and better *C. ovensii* timber along with a statistical summary. This Table also lists the characteristic density information

Table 2 lists the New Zealand characteristic grade stresses for the SG visual grades

Appendices A and B list the raw test data collected.

***Table 1**: No 1Framing Bending Strength and Stiffness properties*

	No 1Framing Ovensii			
	Bending Stiffness MoEj (GPa)	**Bending Strength MoRj (MPa)**	**Density at Test kg/m³**	**Nominal Density kg/m³**
Mean	7.90	51.91	489.53	434.64
Minimum	6.39	28.58	398.64	353.75
Maximum	10.45	71.68	553.55	493.46
Range	4.06	43.10	154.92	139.71
Standard Deviation	0.93	12.89	34.58	31.18
Coefficient of Variation	11.83%	24.84%	7.06%	7.17%
Count	30	30	44	44
Characteristic Strength (MPa)		**32.28**	**501.55**	**447.83**
Characteristic Stiffness (GPa)	**7.78**			
Assigned Grade	**SG 6**	**SG 12**		

Table 2: *Characteristic stresses for SG visually graded timber from NZS1720.1: 2022*

		Moisture Content – Dry (m/c ≤ 15%)							
	Stress Grade	**Design density** kg/m³	**Characteristic density** (ρ') kg/m³	**Bending** (f_b') MPa	**Compression parallel-to-grain** (f_c') MPa	**Tension parallel-to-grain** (f_t') MPa	**Tension perpendicular-to-grain** (f_{tp}') MPa	**Short duration average modulus of elasticity** (E') MPa	**Lower bound short duration modulus of elasticity** (E_{lb}) MPa
Verified timber	SG 15	570	475	41.0	35.0	23.0	0.5	15200	11500
	SG 12	540	450	28.0	25.0	14.0	0.5	12000	9000
	SG 10	500	415	20.0	20.0	8.0	0.5	10000	7500
	SG 8	450	375	14.0	18.0	6.0	0.4	8000	5400
	SG 6	400	330	10.0	15.0	4.0	0.4	6000	4000

NOTES:

1. *Shear in beams for seasoned radiata pine shall be taken as f'_s = 3.8 MPa. shear in beams for seasoned Douglas fir shall be taken as f'_s = 3.0 MPa.*
2. *Bearing perpendicular-to-grain for seasoned radiata pine and Douglas fir shall be taken as f'_p = 6.9 MPa. This strength has been determined in accordance with Section 2.8 of AS/NZS4063 divided by the length of bearing factor k_7. This value includes stress spreading and hanging edge effects and is reported at a deformation of 2mm into the timber. Should the perpendicular-to-grain strength without the effects of stress spreading and hanging edge be required, refer to Franke, S., and Quenneville, P. (2010), The Material Behaviour of Radiata Pine Under Compression, New Zealand Timber Design Journal, VOL 18, ISSUE 3*
3. *Short duration average modulus of rigidity shall be taken as $G' = E'/15$.*
4. *Grades shall be verified in accordance with NZS 3622.*
5. *The design density for use only in computing the dead load due to mass of timber*
6. *The characteristic density is to be used for the design of connections using the detailed method.*

Density and Moisture content

- From the bending test samples a short cross section was then cut from an undamaged clearwood section close to the failure point of each test specimen for density, moisture content
- Moisture content was measured using the oven drying method.
- Nominal density was calculated for each section from the oven dry weight over volume at test.
- Density at test was calculated for each section from the test weight over volume at test.

Table 3 shows a statistical summary of the moisture content and density testing for the entire sample.

Table 3: *Statistical Summary of Density and Moisture content results*

	Moisture Content %	**Density at Test kg/m³**	**Nominal Density kg/m³**
Mean	11.98	505.33	451.35
Minimum	9.94	457.81	411.00
Maximum	14.61	571.54	516.41
Range	4.66	113.74	105.41
Standard Deviation	1.10	29.84	27.94
Coefficient of Variation	9.21%	5.90%	6.19%
Count	30	30	30

CONCLUSION

1. In terms of bending stiffness, the *C. ovensii* achieved the SG6 structural grade, in terms of bending strength, the *C. ovensii* achieved the SG12 structural grade resulting in an overall grade of SG6.
2. To assign a full structural grade the other strength properties tension, compression and shear need to be evaluated.

ACKNOWLEDGEMENTS

Ruapehu Sawmills and Dean Satchell for supplying the 100x50mm structural timber

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.

3. Sargent, R., & Stovold, G. T. (2021). SWP-T116 Grade recoveries from sawing 22-year-old unpruned cypress clones. Report prepared for the Specialty Wood Products Partnership. Scion, Rotorua.
4. Stovold, T., Sargent, R., & Satchell, D. (2019). SWP-FN084 Sawing Cypress Clones - Green recovery. File Note prepared for the Specialty Wood Products Partnership. Scion, Rotorua.

APPENDICES

Appendix A: *C. ovensii* Test data

Lab No.	Board Reference	Visual Grade	Width (mm)	Depth (mm)	MoEj (GPa)	MoRj (MPa)	Moisture Content (%)	Density at Test kg/m^3	Nominal Density kg/m^3
286589	42847-3	1F	50.93	100.91	7.69	51.21	14.48	516.77	451.42
286596	42847-2	1F	52.59	101.32	7.15	59.94	14.61	518.63	452.52
286601	OV-19	Eng	49.08	101.15	7.35	54.02	12.39	467.87	416.29
286607	OV-19	1F	48.84	101.66	8.51	61.31	12.68	492.05	436.68
286608	OV-10	Eng	50.18	99.94	7.81	59.97	11.95	480.45	429.16
286609	OV-5	1F	47.66	97.09	7.45	62.06	11.61	542.55	486.10
286611	OV-13	1F	53.76	88.33	6.87	58.49	11.45	524.89	470.95
286612	OV-21	Eng	47.83	99.43	7.07	48.52	13.12	493.17	435.98
286613	OV-23	Eng	51.13	101.62	7.27	66.16	12.17	516.65	460.58
286614	OV-10	1F	50.08	98.85	9.23	38.42	11.48	465.88	417.92
286617	OV-13	1F	55.12	90.46	8.13	62.13	11.77	526.66	471.18
286618	OV-21	1F	51.57	100.50	8.17	58.28	13.26	504.55	445.47
286619	OV-12	1F	53.21	101.25	6.39	57.97	12.46	541.13	481.17
286620	OV-9	1F	49.78	97.09	7.11	28.79	11.60	533.70	478.21
286621	OV-14	1F	50.56	98.37	9.19	34.32	12.05	495.77	442.46
286622	OV-8	1F	53.06	91.52	7.45	49.53	12.18	553.55	493.46
286623	OV-7	1F	54.98	99.96	8.88	38.11	11.96	469.71	419.53
286624	OV-20	Eng	52.61	101.21	7.99	71.68	12.51	467.82	415.81
286625	OV-22	1F	49.82	101.68	8.26	67.17	12.54	515.34	457.90
286626	OV-14	Eng	50.37	98.51	7.16	56.93	11.39	457.81	411.00
286628	OV-8	1F	49.70	99.15	7.42	60.07	11.39	478.44	429.51
286629	OV-7	1F	51.95	99.05	8.50	61.56	11.44	475.35	426.55
286630	OV-20	Eng	51.10	101.67	9.57	71.42	11.92	481.84	430.53
286631	OV-22	Eng	49.37	102.00	6.65	45.77	12.83	495.40	439.08
286632	OV-25	Eng	54.00	101.58	7.53	46.18	12.76	471.89	418.49
289679	Hayes 1	2F	49.94	99.05	10.45	41.39	9.94	516.42	469.71
289680	Hayes 2	1F	50.13	98.92	8.76	29.66	10.43	514.88	466.24
289681	Hayes 3	1F	50.36	99.99	8.30	55.84	10.19	531.62	482.44
289682	Hayes 4	1F	50.67	97.85	6.97	31.72	10.68	571.54	516.41
289683	Hayes 5	1F	52.88	99.88	7.70	28.58	10.22	537.59	487.72