MOISTURE METER CORRECTION FIGURES FOR NELSONPINE LVL FRAMING

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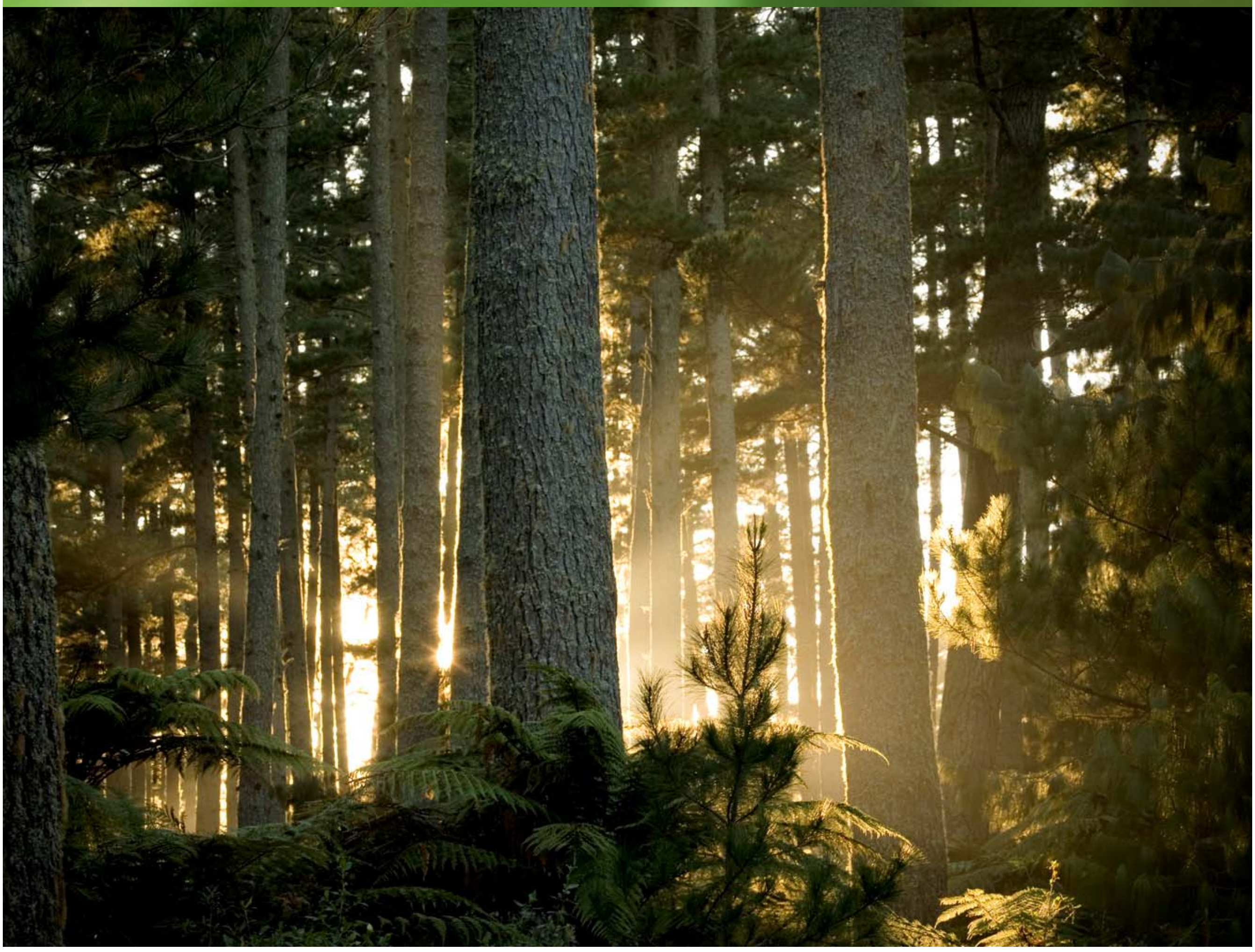

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INTRODUCTION

Moisture meters are widely used in the timber and building industry to check the moisture content of structural timber and house framing. Nelson Pine Industries Limited are producing NelsonPine LVL which is an engineered wood composite treated to H1.2 with Azotek glueline and face spray treatment.

This report presents moisture meter correction figures for NelsonPine LVL framing, for a resistance type moisture meter (Carrel & Carrel) and a capacitance type moisture meter (Wagner L612).

PROCEDURE

- Nelson Pine Industries Limited supplied 90x45 mm LVL8 H1.2 radiata pine LVL framing timber for this study. Twenty 1 metre long pieces were treated to H1.2 with Azotek glueline and face spray treatment.
- A phenolic adhesive was used for the LVL manufacture.
- Each 1 metre length was cut to give four 200 mm long end-matched samples.
- One sample from each original 1 metre length was placed in one of four controlled environment rooms operating at 25°C, and approximately 5%, 7%, 12% and 19% moisture content.
- The samples were allowed to equilibrate in each environment for 14 weeks.
- The moisture content of each sample was measured using a:
    - Carrel & Carrel C201 resistance type moisture meter calibrated to NZS 1080.1. The moisture meter was set to a temperature of 20°C and Species of 0 (zero). The insulated electrode pins were inserted into the face of the LVL, parallel to the long edge of the sample. Readings were taken with a sliding hammer type of electrode, with the electrode inserted 15 mm into the face of the wood sample.
    - Wagner L612 capacitance type moisture meter. The specific gravity setting of the meter was 0.46. A meter reading was taken on one face of each sample.
    - The calibration of the moisture meters was checked against the manufacturers' standard at intervals during testing.
    - Each sample was weighed after the moisture meter measurements were taken.
- The moisture meter readings were not temperature corrected as the wood temperature was close to 20°C.
- The actual moisture content of each sample was determined by oven drying (AS/NZS 1997).

- Regression models were fitted for relating meter readings to true moisture content. These models were fitted with SAS Version 9.3 statistical analysis software using the procedure MIXED. Quadratic models of the following form were found appropriate:

  (1) $y = a + bx + cx^2$

  where y is the meter reading, x is the true moisture content, and a, b, and c are regression coefficients.

  Residual variation was found to increase with mean moisture content. Therefore, the models were fitted using the MIXED procedure with residual variance increasing as a power of moisture content, i.e.:

  (2) $Variance = \sigma^2 \exp(\gamma x)$

  where σ^2 and γ are model coefficients.

  Tables for converting meter readings to mean true moisture content were obtained by inverting Equation (1), i.e.,

  (3) $x = \left(-b \pm \sqrt{b^2 - 4(a - y)c}\right) / (2c)$

  Conservative meter readings for ensuring samples have lower than 20% moisture content were obtained using the SAS MIXED procedure to estimate the 5th percentile of the distribution of observations around the regression line at $x = 20\%$.

RESULTS

Regression model coefficients for Equations (1) and (2) along with R^2 values indicating model fit are given in Table 1.

Table 1. Regression coefficients and R^2 value.

Parameter	Carrel & Carrel C201	Wagner L612
a	0.814	7.81
b	1.158	-0.329
c	0.0231	0.0843
σ^2	0.0833	0.125
γ	0.271	0.151
R^2	0.96	0.99

Table 2 gives conversions between meter readings and mean true moisture content obtained using Equation (3). Note that the Wagner L612 meter does not display meter readings above 32.

Table 2. Tables for converting meter readings to true moisture content for NelsonPine LVL samples.

Meter reading	True %MC, Carrel & Carrel C201 resistance type moisture meter	True %MC, Wagner L612 capacitance type moisture meter
8	5.6	4.4
9	6.3	6.2
10	7.0	7.4
11	7.6	8.4
12	8.3	9.3
13	8.9	10.0
14	9.6	10.7
15	10.2	11.4
16	10.8	12.0
17	11.4	12.6
18	12.0	13.1
19	12.6	13.6
20	13.1	14.1
21	13.7	14.6
22	14.2	15.1
23	14.8	15.5
24	15.3	15.9
25	15.9	16.4
26	16.4	16.8
27	16.9	17.2
28	17.4	17.5
29	17.9	17.9
30	18.4	18.3
31	18.9	18.7
32	19.4	19.0
33	19.9	-
34	20.4	-
35	20.8	-

The 5th percentiles of meter readings for samples with a true moisture content of 20% are given in Table 3. At these readings, 95 out of 100 samples will be below 20% true moisture content.

Table 3. Fifth percentiles of meter readings for samples with a true moisture content of 20%.

Moisture meter	5th percentile at 20% MC
Carrel & Carrel C201 resistance type moisture meter	25.9
Wagner L612 capacitance type moisture meter	32

Figures 1 and 2 show the data, fitted regression models, and 5th percentile lines.

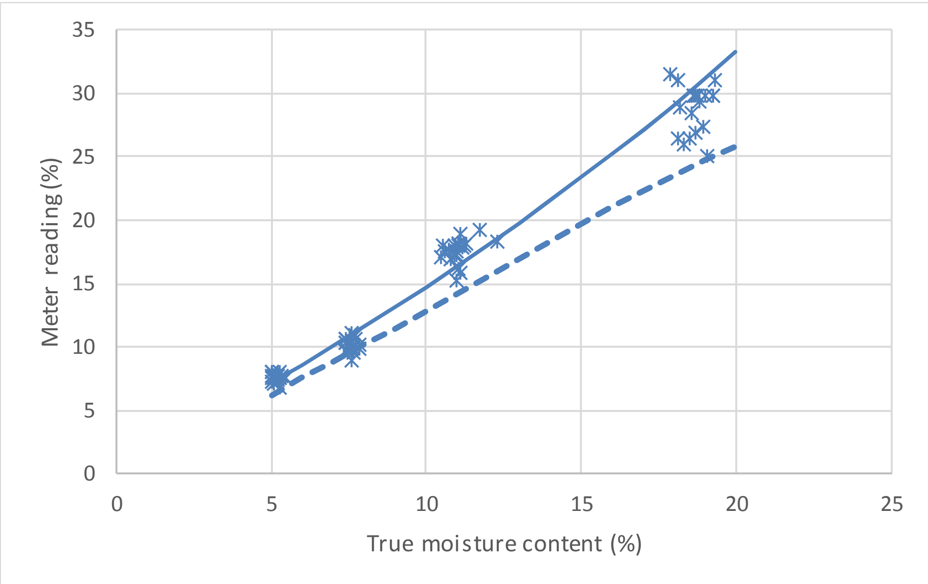

Figure 1. Meter readings using the Carrel & Carrel C201 resistance type moisture meter plotted against true moisture content for 80 NelsonPine LVL samples. Also shown are the quadratic regression model (solid line) and the 5th percentile (dashed line).

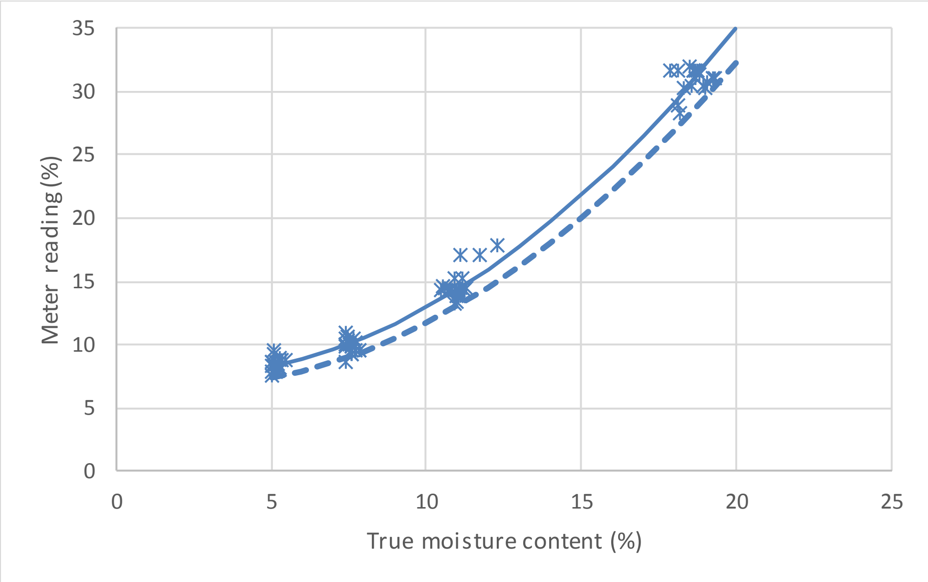

Figure 2. Meter readings from the Wagner capacitance type moisture meter plotted against true moisture content for 80 NelsonPine LVL samples. Also shown are the quadratic regression model (solid line) and the 5th percentile (dashed line).

LVL significantly affects the resistance moisture meter. Table 2 shows that a meter reading of 34 corresponds to a predicted moisture content of 20% for NelsonPine LVL. This effect is most likely due to the increased conductivity provided by the adhesive used in the LVL construction.

There is a large meter correction with the capacitance type moisture meter. This is likely to be caused by the increased density of the LVL compared to sawn timber. Average basic density of sawlogs is between 385 and 440 kg/m^3 (Cown, 1999). The density of 10 LVL samples at the time of testing ranged from 458 to 507 kg/m^3. The calibration of the Wagner L612 can be altered by changing the Specific Gravity (S.G.) setting. An S.G. setting of 0.46 was used for this study, but a higher value of S.G. will alter the relationship between meter reading and moisture content.

CONCLUSIONS

- LVL has a major effect on both types of moisture meter.
- A resistance moisture meter reading of 33 corresponds to a predicted moisture content of 20% for NelsonPine LVL.
- There is a large scatter in the resistance meter readings which means great care must be exercised when interpreting the results.
- The large correction for resistance meters may cause a problem for moisture meters which do not display to such high meter readings.

RECOMMENDATIONS

- When using a moisture meter to determine if a piece of LVL is below 20% moisture content, use the upper confidence interval for individual readings. See Table 4.

TABLE 4: Maximum moisture meter reading to predict a moisture content of less than 20% (95 times in 100 times)

Moisture meter	NelsonPine LVL
Resistance (Carrel & Carrel C201)	26
Capacitance (Wagner L612)	32

- Procedures for testing the moisture content of house framing are defined by BRANZ (BRANZ, 2015). This publication recommends that resistance type moisture meters are used for testing house framing as the capacitance type meters are insensitive to moisture gradients.
- Moisture meter operators should be aware that moisture meters do not give a precise measure of moisture content. It is important to take moisture meter readings from a variety of samples to get a good measure of the moisture content. The New Zealand standard includes recommendations on the use of moisture meters and indicates the number of measurements that should be taken (AS/NZS 1997).

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