FLEXURAL AND TENSILE PROPERTIES OF 2 × 6 AND 2 × 10 SOUTHERN PINE LUMBER

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Abstract. Bending modulus of elasticity (MOE) and tensile properties parallel to the grain were studied on 702 pieces of 2 × 6 and 285 pieces of 2 × 10 No. 2 visually graded southern pine lumber. The overall rings per inch (RPI) in 2 × 6 pieces was 4.82, whereas 2 × 10 had an RPI average of 3.82. For latewood percentage (LW), 2 × 6 pieces found 45.88% of LW and 45.02% for 2 × 10 pieces. Bending MOE (E_b) mean for 2 × 6 was 10,615 MPa, whereas for 2 × 10 lumber, the mean was 13,665 MPa. The tension MOE (E_t) mean for 2 × 6 lumber was 11,339 MPa, whereas for 2 × 10 the mean was 9735 MPa. The ultimate tensile stress (UTS) mean for 2 × 6 lumber was 28.42 MPa and the overall mean UTS for 2 × 10 lumber was 24.51 MPa. Linear regression models were useful to explain the relationship between E_b and E_t. Strong coefficients of determination ($r^2 = 0.70$ and $r^2 = 0.74$) were found for both lumber sizes between these two properties. Moderate relationships ($r^2 = 0.43$ up to $r^2 = 0.51$) between E_b and UTS were also found for both lumber sizes. However, weaker relationships were found between E_t and UTS ($r^2 = 0.32$ up to $r^2 = 0.40$). Three distributions were fit to the E_b, E_t, and UTS data and evaluated for goodness of fit. The results suggest that E_b of 2 × 6 lumber might be adequately modeled by a normal distribution, and tensile properties of 2 × 10 lumber might be adequately modeled by a lognormal distribution.

Keywords: Bending modulus of elasticity, tension modulus of elasticity, ultimate tensile stress, structural lumber, lognormal distribution.

INTRODUCTION

Southern yellow pine (*Pinus* spp.) is one of the most abundant commercial timber resources in the United States (França et al 2018a; Southern

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Forest Products Association 2022). From all the grades of southern pine available in the market, No. 2 visually graded lumber remains the most vastly produced lumber. Mechanical properties of southern pine dimensional lumber can be affected by several characteristics though the most commonly associated with the high variation observed in bending and tensile strengths are knots and grain angle. Since design values for southern pine changed in 2012, it is important to continue monitoring the physical and mechanical properties of this timber resource (Gerhards et al 1972; França et al 2018a).

The mechanical properties of lumber vary regardless of the species and size (Forest Products Laboratory 2021). The continuous evaluation of southern pine lumber properties through destructive and nondestructive methods contributes to guaranteeing its quality and maximizing its utility value (França et al 2021). Studying the relationships between lumber properties is essential to deriving allowable properties for lumber (Yang et al 2017). In addition, property relationships, such as the one between modulus of elasticity (MOE) and modulus of rupture (MOR), are frequently used in machine-graded structural lumber. Developing strength property relationships is important because it helps estimate untested properties.

The quality control process for machine-stress-rated (MSR) lumber and machine-evaluated-lumber (MEL) differ in loading methods. For MSR, pieces are tested daily to obtain at least one strength property and MOE in edgewise orientation. On the other hand, MEL requires daily tension quality control alongside tests in edgewise orientation to assess stiffness and bending strength (Forest Products Laboratory 2021). Research on bending and tensile properties allows the wood industry to optimize the sorting processes of lumber. Linear regression models are extensively used to study property relationships because they help reduce costs associated with large lumber-testing programs (Green and Evans 1988; Entsminger et al 2020).

Bending properties include MOE (E_b) and MOR. The MOE is also known as the stiffness of a material. This property is one of the most important because it is a good indicator of load resistance (Wang et al 1993; Nzokou et al 2006; Amishev and Murphy 2008). Stiffness can be determined through static bending or nondestructive tests (Woeste et al 1987; Liliefna 2009). Several authors have conducted studies to analyze the bending property relationships of southern pine lumber (Yang et al 2015, 2017; França et al 2022). Since MOE is used to predict MOR, it is of significant interest to understand the relationship between MOE and tensile properties (Liliefna 2009).

Studies regarding the relationships between MOE and tensile properties are documented in the literature. The study conducted by Doyle and Markwardt (1967) is one of the earliest and most extensive reports on property relationships of southern pine full-size dimensional lumber. Similarly, Green and Kretschmann (1991) and Senalik et al (2020) studied property relationships for southern pine lumber. More specifically, Senalik et al (2020) studied relationships between dynamic MOE and ultimate tensile stress (UTS). Likewise, As et al (2020) and Liliefna (2009) evaluated flexural and tensile property relationships for other commercial softwood species in North America.

The objectives of this study were to: 1) investigate the relationships between bending MOE (E_b) and the properties of tension MOE (E_t) and UTS of 2 × 6 and 2 × 10 No. 2 visually graded southern pine lumber; 2) Summarize the growth characteristics (number of rings per inch [RPI] and percentage of latewood [LW]) presented in the 2 × 6 and 2 × 10 evaluated lumber; 3) assess the statistical distribution of E_b, $E_{t,}$ and UTS data; and 4) Compare the flexural and tensile properties of 2 × 6 and 2 × 10 southern pine lumber.

MATERIALS AND METHODS

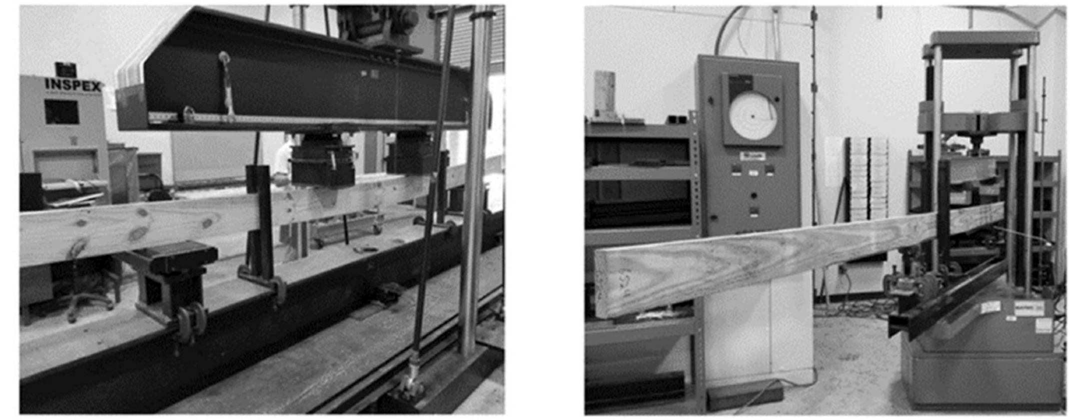
The nominal size for the lumber used in this study was 2 × 6 and 2 × 10, a standardized size that refers to nominal dimensions in inches, where a 2 × 6 is 1.5 × 5.5 inches and 2 × 10 is 1.5 × 9.25 inches. A total of 702 pieces of 2 × 6 and 285 of 2 × 10, No. 2—kiln-dried southern pine lumber were obtained from the 18 commercial

Table 1. Dimensions of 2 × 10 and 2 × 6 southern pine dimensional lumber.

Size (in.)	Thickness (in.)	Width (in.)	Nominal length	Length (m)	Quantity
2 × 6	1.5	5.5	14 ft.	4.27	168
	—	—	16 ft.	4.90	534
2 × 10	1.5	9.25	14 ft.	4.27	85
	—	—	16 ft.	4.88	200

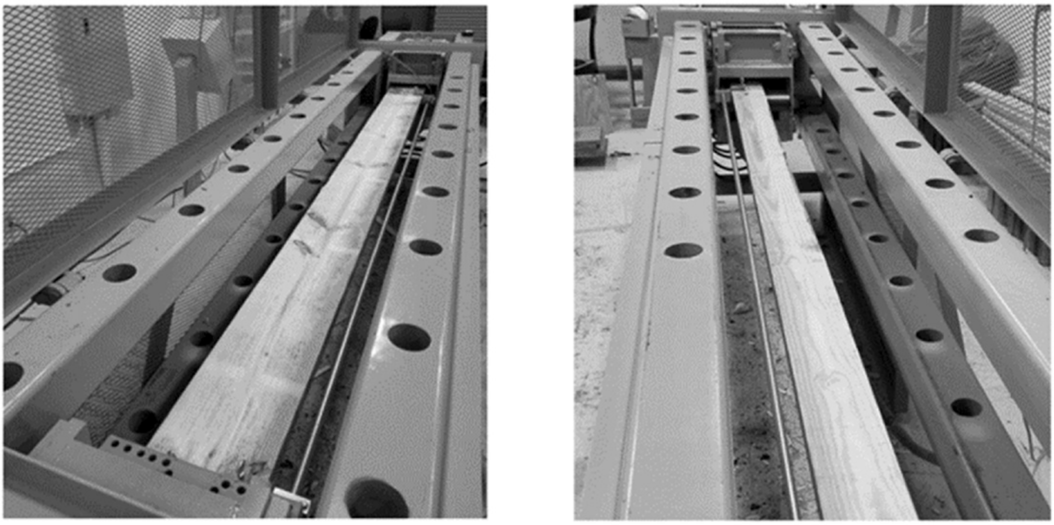
regions of southern pine in the United States (see map França et al 2018b). To verify the grade, all lumber was degraded by a certified grader from either Southern Pine Inspection Bureau (SPIB) or Timber Products Inspection (TP). Table 1 shows the dimensions of the evaluated lumber. Each specimen was labeled at both ends with an identification number. The sample preparation, testing procedures, and statistical analysis performed are summarized as follows:

1. The lumber was conditioned to an average moisture content (MC) of 12%. Lumber was stacked under a covered breezeway to protect it from sun and rain. MC was measured with a moisture meter reader (Wagner model, MMC 220) in all specimens.
2. The RPI were counted at both ends of each specimen following the procedures from SPIB grading rules (SPIB 2014). The total rings counted were divided by the thickness or the width depending on what direction the rings were counted (radial or tangential direction).
3. The LW percentage was determined using the dot grid method as indicated in Uzcategui et al (2020) in accordance with SPIB grading rules (SPIB 2014).
4. Data on width length and thickness, and weight of each specimen was collected to calculate density. The width and thickness were recorded as an average of two readings taken at both ends. The weight was measured with a digital scale.
5. The E_b was measured for all specimens through proof-load bending tests via four-point static tests in edgewise direction using a span-to-depth ratio of 17:1 (see Fig 1[a] and 1[b]). For 2 × 6 lumber, the ratio span was 3.99 m (13.09 ft.), the rate of the load was 0.80000 in/min and the maximum load was 3336 *N*. For 2 × 10 pieces, the span was also 3.99 m while the rate of the load was 0.300 in/min and the maximum load was 4000 *N*. Procedures followed standards ASTM D198-21 (2021) and ASTM D 4761-19 (2019).
6. The E_t and UTS were measured by conducting destructive tests parallel to the grain using a Tension Proof Loader Model 422 (Metriguard, Pullman, USA). Each specimen was placed horizontally in the tension machine



(a) (b)

Figure 1. Test setup to determine the flexural modulus of elasticity (MOE or E_b) (Proof-load bending test). (a) Test conducted on 2 × 10 lumber. (b) Test conducted on 2 × 6 lumber.



(a) (b)

Figure 2. (a) Test setup used to determine tension parallel to the grain properties of 2 × 10 lumber. (b) 2 × 6 southern pine lumber.

(see Fig 2[a] and 2[b]) and held by metallic grips at both ends while the test was performed. For 2 × 6 and 2 × 10 pieces, the span of testing was 2.44 m (96 in.) for the shorter lumber (14 ft.) and 2.97 m (117 in.) for the longer pieces (16 ft.). Tension tests were performed following the standard D198-21 (ASTM 2021).

7. The statistical software SAS version 9.4 (SAS Institute 2013) was used to obtain descriptive statistics, Analysis of Variance (ANOVA), and linear regression models. ANOVA was calculated at the $\alpha = 0.05$ significance level. The models were created for tensile properties (E_t and UTS) using E_b as the predictor variable. Data was organized taking into consideration the length of each specimen. The coefficient of determination (r^2) was calculated. The E_b, E_t, and UTS data were tested for goodness of fit using the Cramer–von Mises (CVM-sim) test for normal, lognormal, and three-parameter Weibull distributions selected by PROC UNIVARIATE and the histogram option in SAS. Statistical analyses and associated graphs were created following procedures from standard D2915-17 (ASTM 2022).

RESULTS AND DISCUSSION

The physical and mechanical properties of 2 × 6 and 2 × 10 southern pine lumber are summarized in Tables 2 and 3. A preliminary analysis revealed no statistically significant differences between the mechanical properties mean values using the length factor (14 and 16 ft.). For 2 × 6 pieces, the MC mean was 12.20%, the min, was 6.60% and the max was 20.10% with a coefficient of variation (COV) of 17.20%. For 2 × 10 pieces, the MC mean was 11.82% and it ranged between 7.20% and 20.70% with a COV = 18.60%.

Table 2. Overall results for moisture content percent (MC %), density, rings per inch (RPI), and percentage of latewood (LW) on 2 × 6 and 2 × 10 (14 and 16 ft. combined) southern pine dimensional lumber.

	Nominal size	Mean	Min	Max	COV (%)
MC (%)	2 × 6	12.20	6.60	20.10	17.20
	2 × 10	11.82	7.20	20.70	18.60
Density ($kg{\cdot}m^{-3}$)	2 × 6	560.12	416.00	763.00	9.79
	2 × 10	547.02	436.00	754.00	9.74
RPI	2 × 6	4.82	1.02	18.33	47.40
	2 × 10	3.82	1.67	15.67	48.24
LW (%)	2 × 6	45.88	18.75	82.81	23.62
	2 × 10	45.02	21.09	76.56	21.07

COV, coefficient of variation.

Table 3. Overall results for bending MOE (E_b), tension MOE (E_t), and ultimate tensile stress (UTS) parallel to grain on 2 × 6 and 2 × 10 (14 ft. and 16 ft. combined) southern pine dimensional lumber.

	Nominal size	Mean (MPa)	Min (MPa)	Max (MPa)	COV (%)[a]
Bending MOE (E_b)	2 × 6	10,615	3994	18,547	24.34
	2 ×10	13,365	7162	22,103	21.88
Tension MOE (E_t)	2 × 6	11,339	3942	22,088	28.30
	2 × 10	9735	4415	18,548	25.62
UTS	2 × 6	28.54	5.33	80.14	49.45
	2 × 10	24.42	7.40	72.97	47.67

COV, coefficient of variation.

For 2 × 6 pieces, the density mean was 560.12 $kg{\cdot}m^{-3}$, the min was 416.00 $kg{\cdot}m^{-3}$ and the max was 763.00 $kg{\cdot}m^{-3}$ with a COV of 9.79%. For 2 × 10 pieces, the density mean was 547.02 $kg{\cdot}m^{-3}$, and it ranged between 436.00 $kg{\cdot}m^{-3}$ and 754.00 $kg{\cdot}m^{-3}$ with a COV = 9.74%. The RPI mean, min, and max for 2 × 6 pieces were 4.82, 1.02, and 18.33, respectively. For 2 × 10 pieces, the RPI mean was 3.82 and it ranged between 1.67 and 15.67. The COV obtained from evaluating RPI was over 40% for both lumber sizes.

The LW percentage for 2 × 6 pieces was 45.88%; the min was 18.75%, and the max was 82.81% with a COV of 23.62%. For 2 × 10 pieces, the LW percentage mean, min, and max were 45.02%, 21.09%, and 76.56%, respectively. The COV found for LW percentage on 2 × 10 pieces was 21.07%. Density, RPI, and LW percentage results for both lumber sizes are comparable with the ones reported by Irby et al (2020) and França et al (2018a, 2018b, 2019a, 2019b).

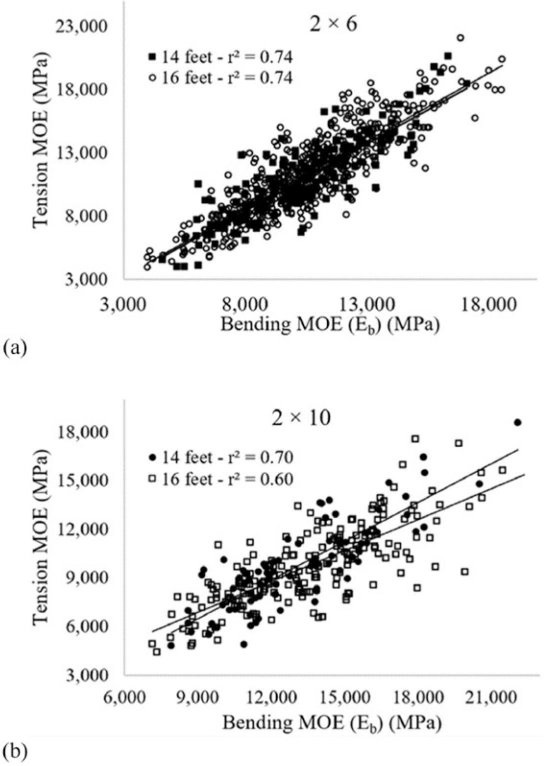


Figure 3. Relationships between bending MOE (E_b) and tension MOE (E_t) for (a) 2 × 6 southern pine pieces; and (b) 2 × 10 southern pine pieces.

For 2 × 6 pieces, the E_b mean was 10,615 MPa; the min was 3994 MPa and the max was 18,547

Table 4. Values of ANOVA for rings per inch (RPI), percentage of latewood (LW), bending MOE (Eb), tension MOE (Et), and ultimate tensile stress (UTS) depending on the size of lumber.

Property	Factor	DF	SS	MS	F	*p*
RPI	Size	1	205.23	205.23	43.73	<0.0001
	Error	985	4623.09	4.69	—	—
LW (%)	Size	1	148.46	148.46	1.36	0.2446
	Error	985	107,906.35	109.55	—	—
E_b	Size	1	1,540,048,721	1,540,048,721	213.52	<0.0001
	Error	985	7,104,453,605	7,212,643	—	—
E_t	Size	1	521,183,241	521,183,241	57.13	<0.0001
	Error	985	8,986,067,112	9,122,911	—	—
UTS	Size	1	3426.77	3426.77	18.95	<0.0001
	Error	985	178,080	180.79	—	—

DF, degrees of freedom; SS, the sum of squares; MS, mean sum of squares; F, Fisher's F-test; p, significance level.

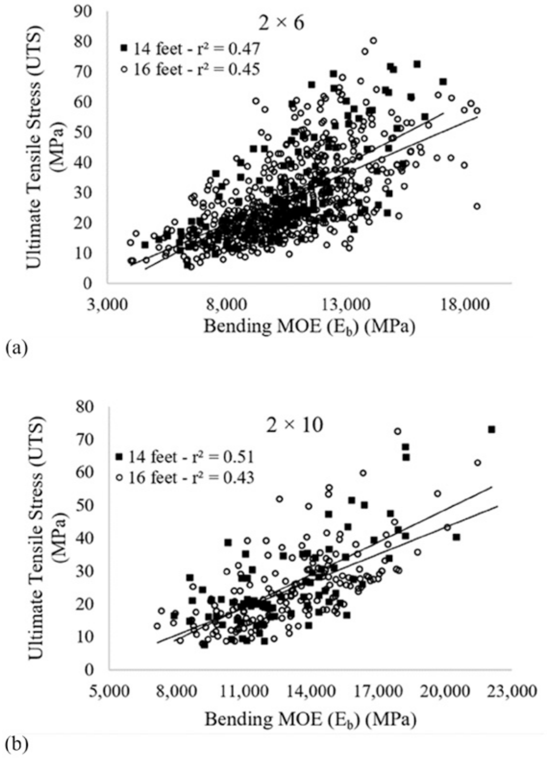


Figure 4. Relationships between bending MOE (E_b) and ultimate tensile stress (UTS) for (a) 2 × 6 southern pine pieces, and (b) 2 × 10 southern pine pieces.

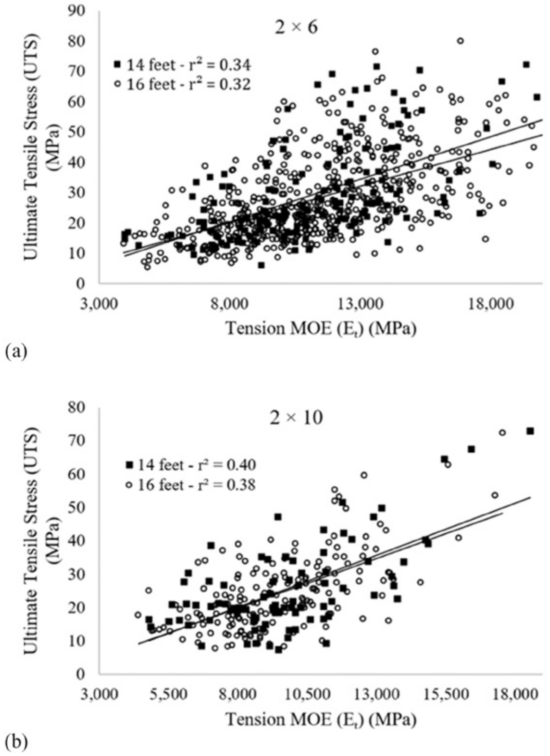


Figure 5. Relationships between tension MOE (E_t) and ultimate tensile stress (UTS) for (a) 2 × 6 southern pine pieces and, (b) 2 × 10 southern pine pieces.

MPa with a COV of 24.34%. For 2 × 10 pieces, the E_b mean, min, and max were 13,365, 7162, and 22,103 MPa, respectively. The COV for 2 × 10 pieces was 21.88%. Overall, the E_b mean value of 2 × 6 pieces is lower than the mean value obtained on 2 × 10 pieces. The E_b results for both lumber sizes are comparable to the ones reported by França et al (2018b, 2019b) and Doyle and Markwardt (1967).

Regarding the tensile properties, the overall mean for E_t on 2 × 6 pieces was 11,339 MPa, ranging from 3942 up to 22,088 MPa with a COV of 28.30%. For 2 × 10 pieces, the mean E_t was 9735 MPa, the min was 4415 MPa and the max was 18,548 MPa with a COV of 25.62%. The UTS mean for 2 × 6 pieces were 28.54 MPa with a min of 5.33 MPa, a max of 80.14 MPa, and a COV of 49.45%. For 2 × 10 pieces, the UTS mean was 24.42 MPa, ranging from 7.40 to 72.97 MPa with a COV of 47.67%. The E_t and UTS mean values obtained on 2 × 6 pieces are slightly higher than the ones for 2 × 10 pieces. Doyle and Markwardt (1967) reported E_t mean values for 2 × 6 and 2 × 8 No. 2 SYP lumber (at 12% MC) that are slightly

Table 5. Summary of the goodness of fit for bending MOE (E_b), tension MOE (E_t), and ultimate tensile stress (UTS) for No. 2 grade southern pine lumber by size.

	2 × 6		
Distribution	E_b	E_t	UTS
Normal	0.250[a]	0.038	0.005
Lognormal	0.005	0.005	0.052
Weibull	0.010	0.010	0.010
	2 × 10		
Normal	0.028	0.039	0.005
Lognormal	0.037	0.333[a]	0.500[a]
Weibull	0.010	0.010	0.010

[a] Indicates the goodness of fit tests that failed to reject.

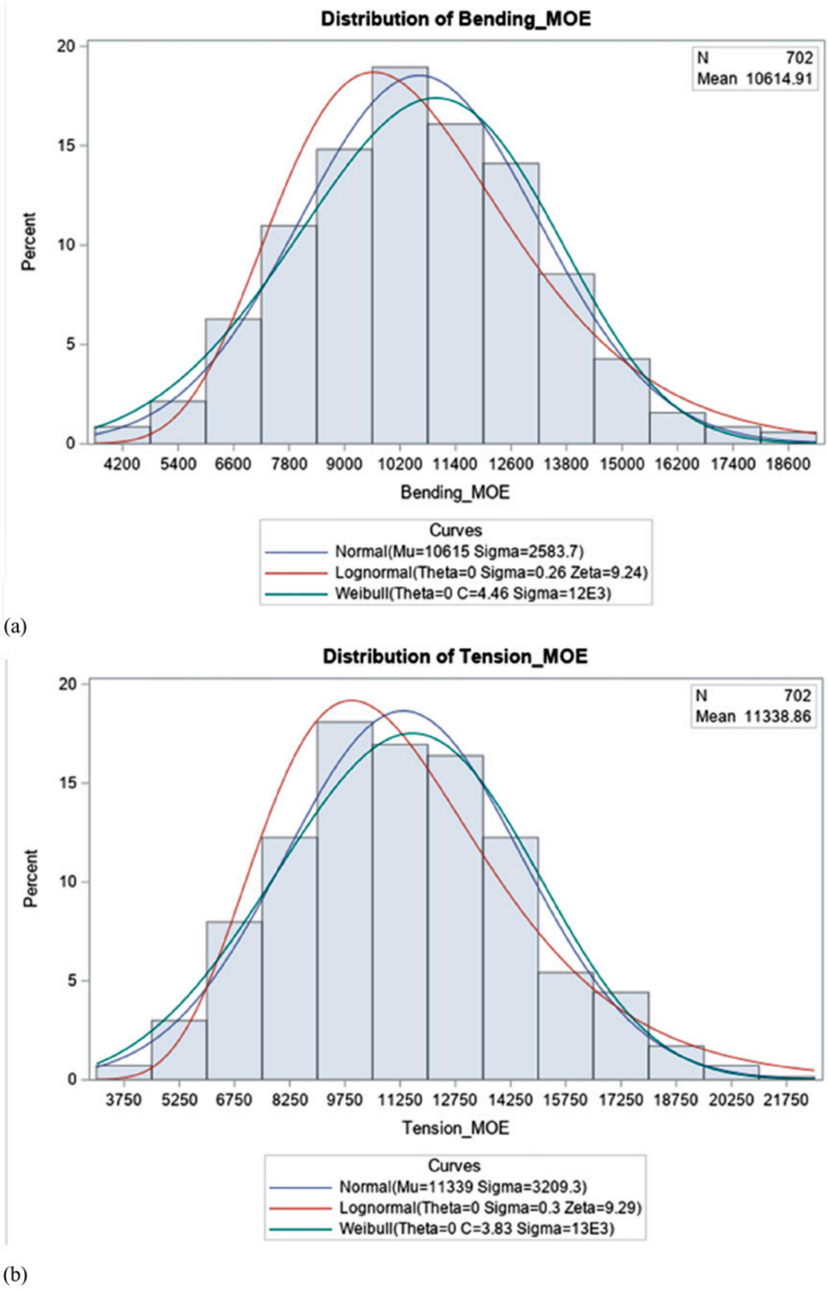


Figure 6. Distribution of (a) bending MOE (E_b), and (b) tension MOE (E_t), for 2 × 6—No. 2 southern pine lumber.

higher than the ones presented in this study. The same authors reported UTS values that ranged between 6.89 and 71.91 MPa.

An ANOVA was performed to evaluate whether there were significant differences among sizes regarding the growth characteristics and the flexural and tensile properties (see Table 4). The results show that there was a statistically significant difference between RPI ($p = <0.0001$) with respect to the size of the lumber. The RPI for

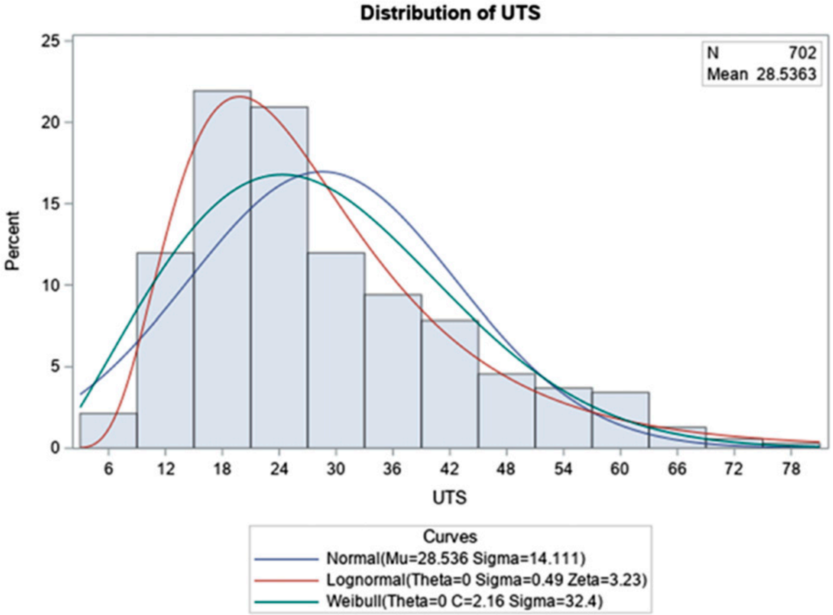


Figure 7. Distribution of ultimate tensile stress (UTS) for 2 × 6—No. 2 southern pine lumber.

2 × 10 lumber (3.82) was significantly lower when compared with the RPI for 2 × 6 lumber (4.82). França et al (2018a) stated that RPI decrease as the width of the pieces increase.

For the LW percentage, no statistically significant difference ($p = 0.2446$) was found between the two sizes. These results agree with França et al (2018a). In relation to the elastic and tensile properties, the results show that there is a statistically significant difference in E_b ($p = <0.0001$), E_t ($p < 0.0001$), and UTS ($p = <0.0001$) with respect to the size of the lumber. The reason for these differences lies in the fact that there is a size-effect regarding the mechanical properties of lumber.

Relationships between Flexural and Tensile Properties

Relationships between E_b and tensile properties are presented in Figs 3-5. Simple linear regression models are used to show the relationship between E_b and E_t, E_b and UTS, and E_t and UTS. Figure 3(a) shows a strong relationship ($r^2 = 0.74$) between E_b and E_t for 2 × 6 lumber (14 and 16 ft.). Figure 3(b) shows a moderate to strong relationship between E_b and E_t for 2 × 10 pieces. The pieces 14 ft. in length showed an $r^2 = 0.70$, whereas the longer pieces had an $r^2 = 0.60$. Doyle and Markwardt (1967) found that E_b and E_t were closely related ($r^2 = 0.88$ for 2 × 6 lumber and $r^2 = 0.94$ for 2 × 8 lumber).

Figure 4(a) and (b) show moderate relationships between E_b and UTS for 2 × 6 and 2 × 10 southern pine pieces (both lengths). For 2 × 6 pieces, the r^2 values were 0.47 and 0.45 for 14 ft. and 16 ft. lumber. For 2 × 10 pieces, the r^2 value for 14 ft. lumber was 0.51, whereas for 16 ft. lumber was 0.43. Doyle and Markwardt (1967) found a weak relationship ($r^2 = 0.30$) between E_b and UTS for 2 × 6 southern pine lumber and a moderate relationship between E_b and UTS ($r^2 = 0.54$) for 2 × 8 lumber. Senalik et al (2020) reported an r^2 value of 0.51 between dynamic MOE and UTS. They also reported an improved r^2 value ($r^2 = 0.71$) including additional parameters from the acoustic properties of lumber.

The relationship between E_t and UTS for 2 × 6 and 2 × 10 southern pine lumber is shown in

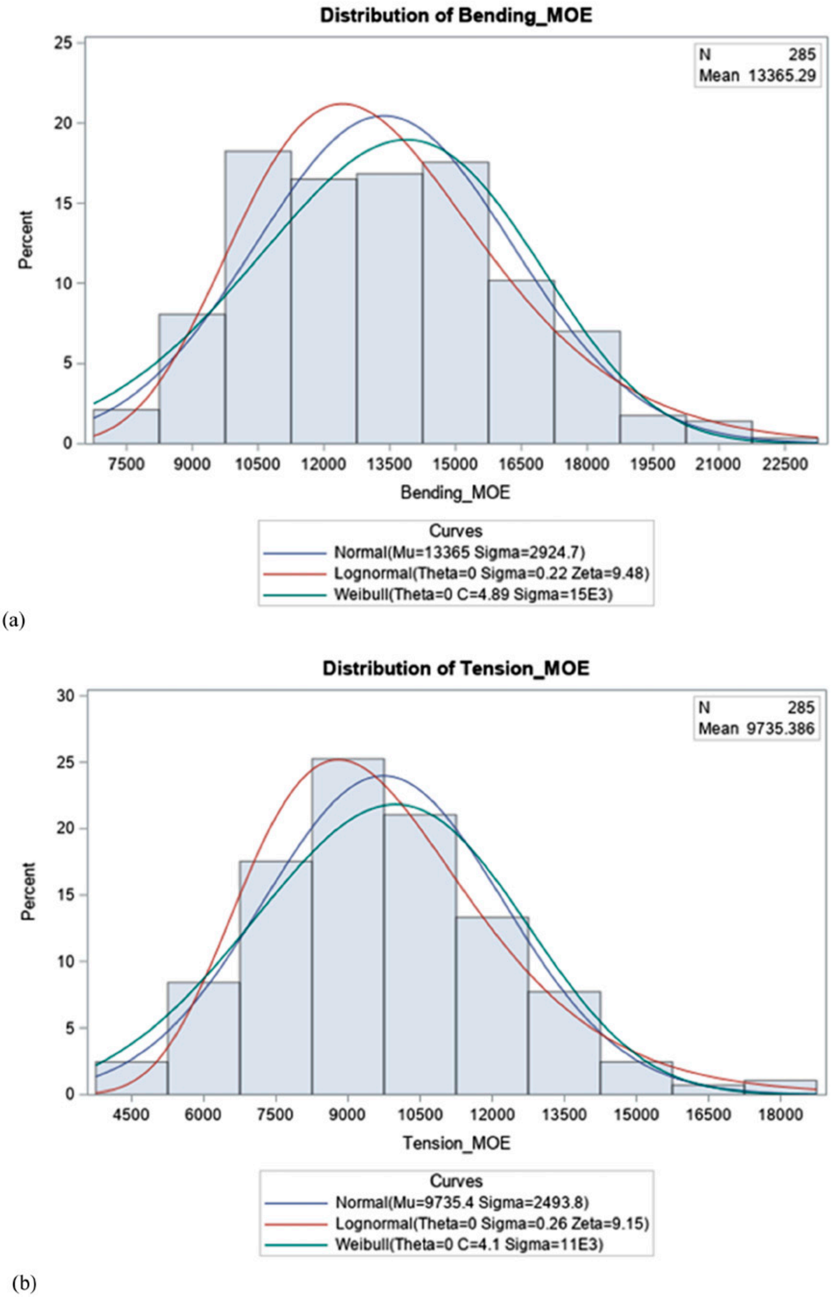


Figure 8. Distribution of ultimate tensile stress (UTS) for 2 × 6—No. 2 southern pine lumber.

Fig 5(a) and (b). Overall, weak relationships were found between these two properties for either lumber size. For 2 × 6 lumber, r^2 values for 14 and 16 ft. lumber were 0.34 and 0.32 respectively. For 2 × 10 lumber, the r^2 value for 14 ft. lumber was 0.40, whereas for 16 ft. lumber, the r^2 value was 0.38. The r^2 values obtained from the relationship between E_t and UTS for 2 × 10 lumber were slightly higher than the r^2 values obtained for 2 × 6 lumber.

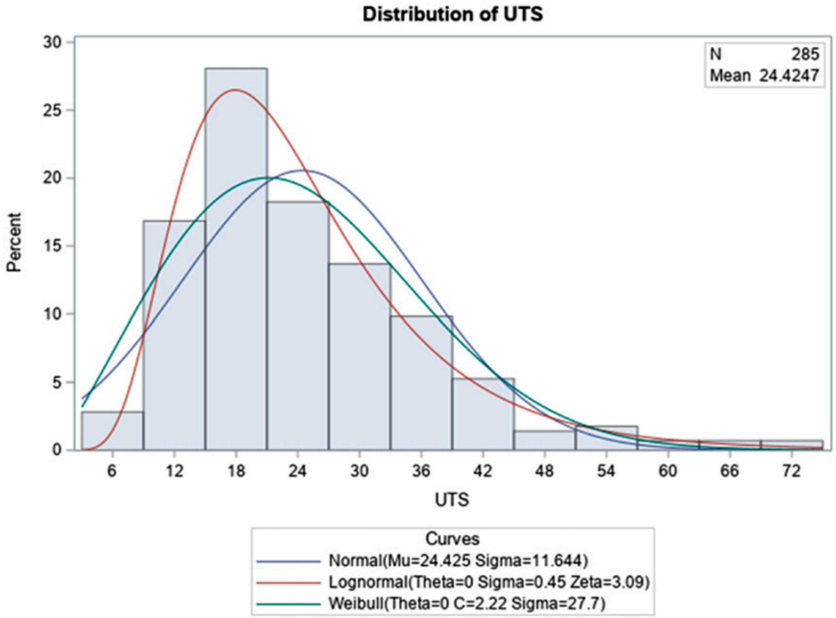


Figure 9. Distribution of ultimate tensile stress (UTS) for 2 × 10—No. 2 southern pine lumber.

Distributions of Flexural and Tensile Properties

Table 5 summarizes the goodness of fit test for E_b E_t and UTS for 2 × 10 and 2 × 6 lumber. For the 2 × 6 lumber, the goodness of fit tests failed to reject the normal distribution for E_b ($p = 0.250$, Fig 6[a]). The CVM-sim test also showed that Weibull and lognormal distributions are not a good fit for the E_b data for 2 × 6 lumber presented in this study. In contrast, none of the three distributions tested (normal, $p = 0.028$; lognormal, $p = 0.037$; Weibull, $p = 0.010$; Fig 7[a]) adequately fitted the E_b data of 2 × 10 lumber. In contrast, Franca et al (2018a) found that the lognormal distribution fitted the E_b of 2 × 6 lumber while the normal distribution fitted best the E_b of 2 × 10 lumber.

The CVM-sim test indicated that none of the distributions (normal, $p = 0.038$; lognormal, $p = 0.005$; Weibull, $p = 0.010$; Fig 6[b]) appeared to adequately fit the E_t data from 2 × 6 lumber. On the other hand, for the E_t data of 2 × 10 lumber, the goodness of fit tests failed to reject the lognormal ($p = 0.33$) distribution, whereas the normal ($p = 0.039$) and Weibull ($p = 0.010$) distributions were not a good fit (see Fig 7[b]).

For UTS, the CVM-sim tests indicated that none of the three distributions (normal, $p = 0.005$; lognormal, $p = 0.052$; Weibull, $p = 0.010$; Fig 8) adequately fitted the data of the 2 × 6 lumber. However, the lognormal distribution ($p = 0.500$) was found to be adequate to model the data of 2 × 10 lumber. The normal ($p = 0.005$) and Weibull ($p = 0.010$) distributions were not a good fit for the UTS data of 2 × 10 lumber (see Fig 9).

Our results show that no single distribution form fitted all mechanical properties evaluated equally well; however, the lognormal distribution was more predominant. It calls our attention that lognormal distributions only fitted the tensile properties of 2 × 10 lumber. For 2 × 6 lumber, none of the distributions appeared adequately fit the tensile properties; and only the normal distribution was a good match for E_b data. Notably, variation in property distributions can be due to a wide range of factors, which can include mill, time, size, species, and strength-reducing characteristics, such as juvenile wood, the slope of grain, knots, forest management practices, and so on (McAlister and Clark III 1991; França et al 2018a; Owens et al 2018; Dahlen et al 2012; Verrill et al 2021).

Dahlen et al (2012) reported that the lognormal distribution adequately fitted MOE data of southern pine lumber. Other studies conducted on mill-run lumber populations suggest that mixed normal distributions could be suitable models for elastic properties while skew-normal or mixed normal distributions might be a good match for MOR data (Owens et al 2018, 2019). In Fig 8 and 9, it is clear that the UTS distribution is right-skewed for both lumber sizes. Looking into the distribution shapes for UTS data of 2 × 6 lumber, it is noticeable that the lognormal distribution appears to be the best fit. Recall that the *p*-value for the lognormal distribution was slightly over the 0.05 threshold ($p = 0.052$). Interpretation of this value is at the discretion of the reader.

CONCLUSIONS

This study provides information on the bending MOE and tensile properties of No. 2 visually graded southern pine lumber based on tests conducted on 702 specimens of 2 × 6 and 285 specimens of 2 × 10-dimensional lumber. The material evaluated was obtained from the 18 commercial growing regions of southern pine in the United States. The MC, when tests were performed, was around 12%. Relationships between bending MOE (E_b) and tensile properties (E_t and UTS) parallel to the grain were analyzed. Analysis of the different distribution models for bending and tensile properties was also presented. For both lumber sizes, the following results were obtained:

The RPI mean, min, and max for 2 × 6 pieces were 4.82, 1.02, and 18.33, respectively. For 2 × 10 pieces, the RPI mean was 3.82 and it ranged between 1.67 and 15.67. The COV obtained from evaluating RPI was over 40% for both lumber sizes.

The LW percentage for 2 × 6 pieces was 45.88%; the min was 18.75%, and the max was 82.81% with a COV of 23.62%. For 2 × 10 pieces, the LW percentage mean, min, and max were 45.02%, 21.09%, and 76.56%, respectively. The COV found for LW percentage on 2 × 10 pieces was 21.07%. Density, RPI, and LW percentage results for both lumber sizes are comparable with the ones reported by Irby et al (2020) and França et al (2018a, 2018b, 2019a, 2019b).

1. The overall RPI mean value in 2 × 6 pieces (4.82) was higher than in 2 × 10 pieces (3.82), and the same trend was found for LW, where 2 × 6 pieces (45.88%) had a slightly higher LW percentage when compared with 2 × 10 pieces (45.02%).
2. A close relationship was found between E_b and E_t.
3. Moderate relationships were found between E_b and UTS.
4. Weak relationships were found between E_t and UTS properties.
5. Normal distribution adequately fitted E_b of 2 × 6 lumber.
6. Lognormal distribution adequately fitted E_t and UTS of 2 × 10 lumber.
7. The 2 × 6 pieces had higher Eb values than the 2 × 10 pieces (10,615 and 13,365 MPa, respectively)
8. The 2 × 10 pieces were higher in Et and UTS (11,339 and 28.54 MPa, respectively) when compared with 2 × 6 (9375 and 24 MPa).

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