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The Influence of Slicing Thickness on the Perpendicular to Grain Tensile Properties of Oak (*Quercus robur* L. and *Quercus petraea* L.) Lamellae

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Abstract: The mechanical properties of sliced lamellae are critical for structural and decorative engineered wood products. This study evaluates the impact of slicing thickness on the tensile mechanical properties of plain oak (*Quercus robur* L. and *Quercus petraea* L.) sliced lamellae, perpendicular to the grain direction. The mechanical performance parameters in terms of the modulus of rupture (MOR), strain at break, and modulus of elasticity (MOE), were analysed using a one-way analysis of variance (ANOVA) and contrast analysis. Our findings indicate that slicing thickness substantially affects the mechanical properties of the modulus of rupture and strain at break, whilst the modulus of elasticity was somewhat independent of the slicing thickness. The mean MOR value increased from 0.8 to 1.43 N mm^{-2} for an increase in the sliced lamellae thickness from 1.5 to 4.5 mm. The strain at break increased, on average, from 1.37 to 2.64% for an increase in the sliced lamellae thickness from 1.5 to 4.5 mm. The MOE was approximately 100–120 N mm^{-2}, indicating a substantially reduced stiffness compared to other sliced lamellae species and solid oak reported values. The slicing check depth ratio diminished from approximately 69% to 50% for an increase in the sliced lamellae thickness from 1.5 mm to 4.5 mm. These findings indicate a negative correlation between the slicing check depth ratio and the tensile performance perpendicular to the grain, suggesting the importance of obtaining an optimal slicing quality. This study employs digital image correlation (DIC) analysis to gain insights into the fracture mechanisms of the tested sliced lamellae and provides an alternative method for strain and stress measuring. The DIC analysis highlighted the role of slicing checks in the stress concentration and ultimate failure areas. This research provides insights into the fracture behaviour of sliced lamellae that are perpendicular to the grain, which is critical for the performance of both structural and decorative products.

Keywords: veneer mechanical properties; tensile strength; slicing checks; digital image correlation (DIC); slicing thickness

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1. Introduction

Sliced lamellae, or veneer sheets produced via flat slicing, are thin wood elements obtained via compression cutting. Veneers are produced through rotary cutting or peeling, i.e., cutting in the wood's tangential direction, and sliced lamellae are produced through parallel to the grain flat slicing. The leading product segment for the veneering industry is plywood, with a global production of 90–100 mln. m^3, according to the European Panel Federation estimates from 2015 [1]. Another significant veneer-based product is laminated veneer lumber (LVL), with approximately 3 mln. m^3 global production [2] and a somewhat high compound annual growth rate (CAGR) of 13.5% [1]. Decorative veneers in the panel industry are also estimated to be a significant market. Flat-sliced lamellae are primarily used in decorative panel lamination, where a crown-cut or timber appearance is desirable. Due to raw material supply challenges, sliced lamellae in product realisation could be extended to a series of multi-layered products such as engineered wood flooring, interior panels, and furniture. The potential impact of extensively using sliced lamellae for joinery products is high; for example, the engineered wood flooring market is estimated at nearly 90 mln. m^2 in Europe alone [3].

The main advantage of the slicing technique over traditional sawing is an increased yield due to no kerf being required when cutting. Due to the kerfless cutting aspect, slicing produces fewer combustion-use by-products than sawing, allowing for the sustainable and cascaded use of the wood raw material. Moreover, slicing technology may increase the fire and health safety of production units compared to traditional sawmills. Hence, the main advantage of the slicing technique resides in producing thin wood elements without compromising the surface quality; therefore, a high volume-to-area conversion ratio is achieved.

Plain and lengthwise slicing are the most common flat slicing techniques [4]. Plain slicing is performed on vertical slicers where the cutting is perpendicular to the material direction, similar to a 0–90 cutting situation [5]. Lengthwise slicing is performed on horizontal slicers using a highly oblique slicing knife and occurs when cutting parallel to the grain, following the specimen feed direction. The advantage of plain slicing over lengthwise slicing is the increased processing speed [6]. Material cutting in slicing occurs via wood compression in front of the knife's cutting edge, assisted by a pressure bar displaced on the back-side of the cut veneer. The role of the pressure bar is to counter excessive tensile forces perpendicular to the grain that would lead to lamellae collapse [4,5]. Hence, parts of the cutting energy may not be countered in the slicing process, and it is released by generating small cracks, known as lathe or slicing checks [5]. Slicing checks are a significant quality issue of sliced lamellae and sliced-lamellae-based products. For instance, slicing checks were shown to negatively influence the shear strength in plywood [7,8] and LVL panels [9].

Considerable research studies on veneer quality have considered slicing check characteristics to be a principal focus area. The depth of the lathe checks in relation to the veneer thickness, known as the check depth ratio and check frequency, were used to characterise slicing checks [4,10,11]. The impact of some production parameters on slicing check characteristics was evaluated, e.g., the pre-treatment temperature, cutting speed and pressure bar geometry, the pre-compression ratio, and species [4]. Wood structure and density significantly impact the slicing quality; therefore, medium- and high-density wood species, i.e., above 500 kg/m^3, require a thermo-hydro pre-treatment before slicing [4]. The pre-treatment temperature was positively correlated with check depth ratio measurements in birch (*Betula pendula* Roth) and beech (*Fagus sylvatica* L.) species [12–14]. In rotary-cut beech veneers, increasing the pre-compression ratio reduced the check depth ratio [14]. A too-high pre-compression may result in significant damage on the pressure bar veneer side as surface roughness and small cracks [15]. The slicing quality depends on the wood species, mainly due to macro-anatomical features such as rays [14]. Maple, birch, and beech sliced lamellae and rotary-cut veneers were found to be tight-cut, i.e., with a check depth ratio below 50% [10,12,16,17], while oak species were found to be loose-cut, i.e., with a check depth ratio above 50% [9,16,18].

Hence, slicing- or sliced lamellae thickness is one of the most critical production variables impacting the processing efficiency and sliced lamellae quality. Sliced lamellae thickness can impact the sustainability aspects of sliced-lamellae-based products, i.e., reduced adhesive consumption with increasing sliced lamellae thickness due to fewer adhesive layers. The check depth ratio was positively correlated with the veneer thickness for rotary-cut beech veneers [9,10], but a negative correlation was found in plain-sliced oak lamellae [18]. Such discrepancies in results may be due to the significant wood fracture mechanisms when cutting in different wood growth directions, i.e., the tangential direction in rotary cutting and a mixture of the tangential and radial direction in plain slicing.

Besides decreasing the mechanical performance of veneer-based products, slicing checks are assumed to impact the surface-checking of veneer and sliced-lamellae-based products [19,20]. Surface-checking is an extensive defect represented by small surface cracks appearing on the veneer's surface and sliced-lamellae-based products. This phenomenon occurs due to residual tensile stresses developed on the surface of a multi-layered structure subjected to a moisture gradient [21]. A significant role in surface-checking is attributed to the low mechanical properties of sliced lamellae. For example, while sliced-lamellae-based engineered wood flooring has exhibited significant surface-checking, the sawn-lamellae-based one showed no surface checking at all [22]. The material edge-chipping was another drawback reported in sliced-lamellae-based engineered wood flooring production [22].

Consequently, knowledge of sliced lamellae's mechanical properties is essential for appropriate product design, quality control, and further investigations on sliced lamellae quality optimisation. Due to the occurrence of slicing checks being mainly in the wood radial direction and surface checking occurring when the material is under surface tension loading, it is assumed that tensile strength perpendicular to the grain is a critical parameter that could describe veneer or sliced lamellae mechanical performance. Regarding this aspect, a relevant study represents the investigation of the mechanical properties of plain- and lengthwise-sliced beech lamellae [6] and birch rotary-cut veneers [23]. Hence, these studies evaluated low slicing thicknesses, i.e., 0.5–1.5 mm. Such lamella thicknesses are uncommon in solid-wood-based flooring product realisation, while the studied species, unlike oak, are generally considered to be suitable for slicing.

Digital image correlation (DIC) is a gradient displacement tracking method used primarily in wood mechanics to analyse fracture occurrence [24,25], characterise various loading cases [26,27], or measure deformations [28]. DIC can also be applied to detect small defects, such as surface checks in veneer-based products [24,29,30]. Therefore, the analysis of sliced lamellae's fracture behaviour could benefit from the use of DIC to gain insights into the role of slicing checks on the failure mechanisms.

Given the importance of veneers and sliced lamellae in various product applications, it is crucial to understand the material mechanical properties and the impact of slicing checks to ensure optimal product performance. Therefore, the primary objective of the current work was to evaluate the effect of slicing thickness on the tensile mechanical properties of oak (*Quercus robur* L. and *Quercus petraea* L.) sliced lamellae. The investigated sliced lamellae thickness was chosen concerning the potential application for engineered wood flooring top-layer manufacturing, i.e., 1.5, 2.5, 3.5, and 4.5 mm. Another objective was to evaluate the correlation between the lamellae slicing check depth ratio and their mechanical performances. The final objective of this study was to analyse the failure mechanisms in sliced lamellae using digital image correlation (DIC). The formulated objectives aimed to provide comprehensive and practical recommendations to guide enhanced product design and application in sliced-lamellae-based products.

2. Materials and Methods

2.1. Materials

The material part of this study's investigations was the sliced lamellae of oak grown in Northern Europe. The sliced lamellae were produced from 32 freshly sawn timber blocks with nominal dimensions of 2500 × 220 × 85 mm. Before slicing, the timber blocks were pre-treated via water soaking at 90 °C for 58 h. Lamellae slicing was carried out on two vertical slicing machines, depending on the nominal thickness. The 1.5 mm sliced lamellae were produced on a typical (low-thickness) veneer slicing of type Cremona, while the 2.5–4.5 mm groups were sliced on a particular Babcock-BSH vertical slicer designed for thick sliced lamellae slicing (Merscha mill in Celje). The slicing parameters, such as the cutting speed, lead (vertical opening between pressure bar and knife cutting edge), gap (horizontal opening between pressure bar and knife cutting edge), and pressure, were adjusted for the cutting thickness based on experienced operator knowledge for optimal quality. Both vertical slicing machines were equipped with a slicing knife with an 18° knife bevel angle. The knives were inspected and resharpened after each block processing. The drying of the sliced lamellae was performed according to manufacturer recommendations;

i.e., the 1.5 and 2.5 mm thick groups were dried on a multi-deck automatic veneer dryer at 80 °C for approx. 8–13 min, while the 3.5 and 4.5 mm groups were dried in a conventional dryer at 40 °C for 4–6 days, including a 24 h indoor climate seasoning step. The resultant moisture content (MC) was measured to be 5.4–6.8% MC for the 1.5 and 2.5 mm thick sliced lamellae and 8.2–8.6% MC for the 3.5 and 4.5 mm thick sliced lamellae after being transported from the production site in Slovenia to the laboratory in Sweden. All sliced lamellae were stored in a climate chamber at room temperature and a relative humidity (RH) of 60% for approximately 24 months, corresponding to approx. 11% equilibrium MC (EMC). Specimen testing was performed at a climate of 30% RH and room temperature for 0 to 28 h.

The tensile mechanical properties of the oak sliced lamellae were determined based on a non-standardised tensile test procedure. The specimen requirements depicted for the perpendicular to the grain tensile testing procedures—such as for the rotary veneers, DIN 52188-1979 [31], or those aimed at solid wood specimens, such as JIS Z 2101, ASTM D143, or ISO 13910 [32]—could not be fulfilled in the case of the sliced lamellae. Due to the characteristic brittleness and potential damage during machining, the specimens were obtained with a rectangular shape, similar to in [6], with nominal dimensions of 150 × 20 mm (length × width) (Figure 1A), and were retrieved from the central part of a sliced lamella. A carpentry band-saw was used to produce the specimens used in this study. Special care was taken to limit induced vibrations in the specimens that could alter their mechanical properties. Six specimens per lamella were cut (from its middle part, i.e., produced with consecutive cuts). The specimens were obtained from straight-grained wood, free of knots, cracks, pith, and sapwood. An additional two specimens per lamella were cut adjacent to the testing specimens to perform slicing check measurements and the DIC analysis. The specimens were obtained from one lamella per sliced flitch (the bundle of sliced lamellae from one timber block). Five flitches per thickness group were randomly selected, i.e., 20 sliced lamellae, resulting in 120 specimens.

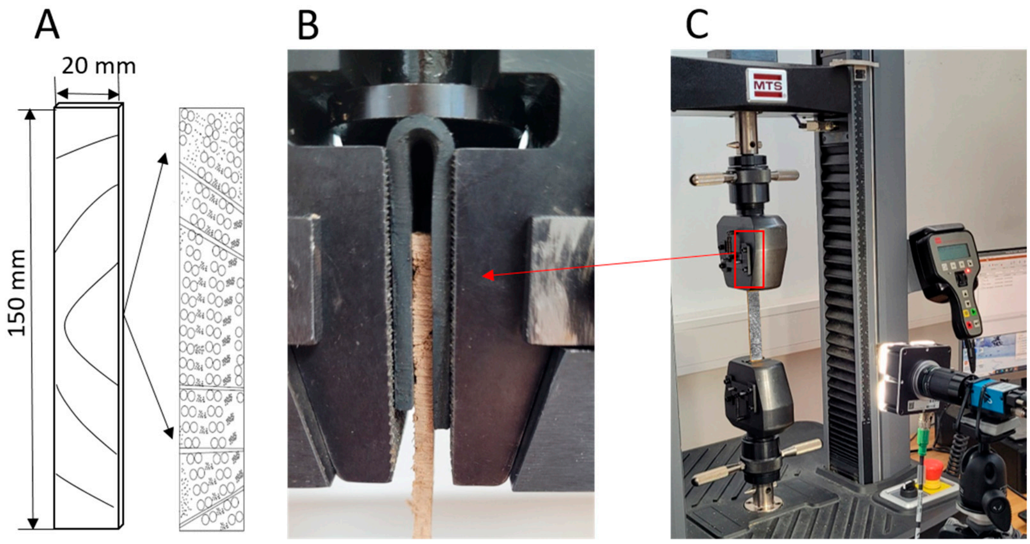

Figure 1. Testing specimens' representation (**A**); specimen fixing in the testing machine's grips (**B**); experimental setup for the DIC acquisition (**C**).

2.2. Methodology

The slicing check characteristics, check depth ratio, and check frequency were measured using a semi-automated detection method based on the surface-staining of the sliced lamellae specimens using a black ink dye, image acquisition of the sliced lamellae cross-section, and the deployment of a slicing check detection algorithm, according to the procedures described in [18]. The algorithm is based on image processing and analysis, i.e., a series of image enhancement and morphological filtering steps to determine the shape of the slicing checks. The method's outputs are the check depth ratio and check frequency.

2.2.1. Mechanical Tensile Tests

Mechanical testing was performed on an MTS Exceed Model E43.104 (MTS Systems Corporation, Eden Prairie, MN, USA) mechanical test machine equipped with a 10 kN load force [33]. During testing, a rubber band was placed between the grips of the testing machine and the tested specimens (Figure 1B). The rubber band's role was to limit potential damages induced by the equipment grips. Special care was given to the specimens' fixation in the grips by adjusting the clamping torque to limit the specimen pre-tension and slippage during testing. Pre-tests on dummy specimens without inserting the rubber band resulted in failure frequently occurring in the fixation area due to the grip-pinching effect.

Tensile tests were carried out at a feed rate of 0.1 mm/min and an acquisition rate of 10 Hz. The feed speed was 0.1 mm/min so that specimen failure would occur after 0.5 to 2 min from the test start. Data acquisition was performed using TW Essential software (version 4.3.1.375) [34]. The modulus of rupture, strain at break, and modulus of elasticity (MOE) were calculated using load–displacement data. The MOE was calculated based on 5% elongation following the default software procedures. The MOE calculus based on manually fitting the elastic interval showed minor deviations from the software output and, therefore, was disregarded.

2.2.2. Statistical Analysis

The data distribution was tested using a one-sample Kolgomorov-Smirnov test using the kstest Matlab2023a function, which resulted in the rejection of the null hypothesis. The Kolgomorov–Smirnov test is a non-parametric test that was used due to its sensitivity to differences between expected and observed distributions and sample size independence [35]. Statistical analysis was conducted using a one-way analysis of variance (ANOVA) to measure the statistical significance of the sliced lamellae thickness's impact on the sliced lamellae mechanical properties, namely the strain at rupture, modulus of rupture (MOR), and MOE. Following the experimental design, grouping was conducted based on the thickness, with four resultant categories, i.e., 1.5, 2.5, 3.5, and 4.5 mm. A one-way ANOVA was performed using anova1 function in Matlab2023a. Post hoc tests were performed to compare the variance between individual groups using a contrast analysis. The contrast analysis was executed using the multcompare Matlab2023a function using Tukey's Honestly Significant Difference (HSD) procedure.

2.2.3. Digital Image Correlation Investigation

The application of the DIC method involves ensuring that the whole surface has unique, random, and high-contrast identifiers to allow the correspondence problem to be solved [36]. A common practice is that the sample's surface must be coated with a white background and black speckled paint layer, or use other synthetic identifiers such as markers [37].

The specimens were prepared for the DIC investigation via manually spraying acrylic paint (Corro Protect) with two hours of drying between the white background layer and the black-coloured speckles. The spraying distance and intensity were adjusted to obtain a black-coloured speckle size of approximately 5 pixels. The specimens were tested 19 h after the final coat application and stored at 60% RH and 23 °C to reach approximately 12% EMC.

The DIC acquisition setup (Figure 1C) was based on a single DMK 33GX183 camera (2D-DIC analysis) equipped with a Fujinon CF25ZA-1S 23MP 25 mm focal length lens at f/1.8. The illumination source was a single-ring SVL R80 light. The image resolution was 26.5 pixels/mm. The image acquisition was performed at two-second intervals until failure detection.

The two-dimensional augmented Lagrangian digital image correlation (2D-ALDIC) algorithm was used for the DIC analysis [37]. The algorithm is based on local and global subset displacement convergence, resulting in a low cost and high precision [38,39]. The deformation gradients and strains were computed using the finite difference method for the Eulerian strain type [39]. For the DIC parameters, the subset size was 20 pixels and the subset step was 10 pixels.

3. Results and Discussion

3.1. Mechanical Properties

The results of the MOE, MOR, and strain at break are presented in Figure 2. The MOR and strain at break generally increase with an increase in the slicing thickness, demonstrated by the increasing median value (red line), the position of the interquartile range (the box) (Figure 2), and the mean group values (Table 1). The MOR was significantly lower for the 1.5 mm thick sliced lamellae, with a mean of 0.8 N mm^{-2}, compared to 1.16–1.43 N mm^{-2} (mean value) for the 2.5 to 4.5 mm thick sliced lamellae, with no significant differences between the 2.5–4.5 mm groups (Table 1). The positive correlation between the slicing thickness and MOR is thought to be due to the increased thickness of the unchecked wood with increasing sliced lamellae thickness, and aligns with the findings on rotary-cut birch veneers [23].

The failure of the sliced lamellae that were subject to tension in the perpendicular-to-grain direction occurred mainly in the radial direction. The sliced lamellae's reduced strength, i.e., several times lower than alternative species studied [6,23], were probably due to the oak species' loose-cut slicing check characteristics and the material's low strength features, such as large earlywood vessels [40].

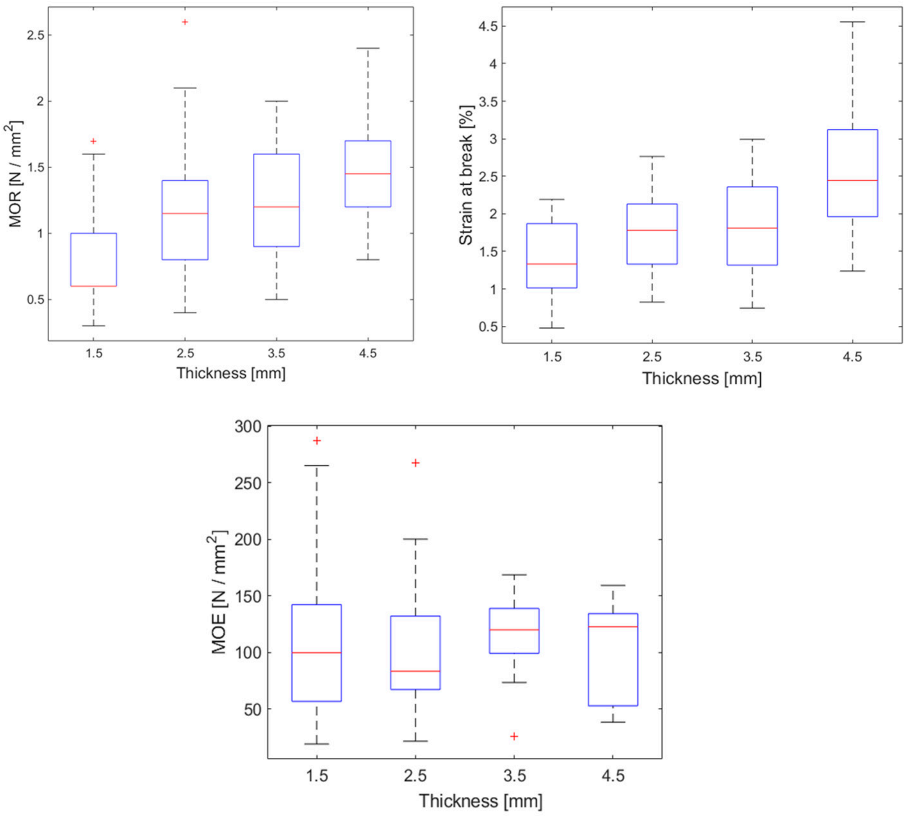

Figure 2. Effect of sliced lamellae thickness on the MOR (**upper left**), strain at break (**upper right**), and MOE (**lower**).

Table 1. MOR, MOE, and strain at break descriptive statistics and ANOVA results.

Thickness (mm)	No. Samples	Mean	Coeff. of Variation (%)	Standard Error	C.I. 95% of the Mean		2-Way ANOVA *p*-Value	*p*-Value ANOVA Contrasts Thickness (mm)			
								1.5	2.5	3.5	4.5
MOR (N mm^{-2})											
1.5	30	0.80	47.88	0.07	0.66	0.95	8.4×10^{-7} *	NA	8.6×10^{-3} *	3.4×10^{-4} *	3.9×10^{-7} *
2.5		1.16	43.33	0.09	0.98	1.35		8.6×10^{-3} *	NA	0.8	0.058
3.5		1.26	33.49	0.08	1.11	1.42		3.4×10^{-4} *	0.8	NA	0.35
4.5		1.43	28.33	0.08	1.28	1.59		3.9×10^{-7} *	0.058	0.35	NA
Strain at break (%)											
1.5	30	1.37	36.33	0.09	1.18	1.56	1.6×10^{-10} *	NA	0.054	0.035 *	5.4×10^{-11} *
2.5		1.79	32.57	0.11	1.57	2.01		0.054	NA	0.99	1.17×10^{-5} *
3.5		1.82	34.41	0.11	1.58	2.05		0.03 *	0.99	NA	2.4×10^{-5}
4.5		2.64	29.50	0.14	2.34	2.93		5.4×10^{-11} *	1.17×10^{-5} *	2.4×10^{-5} *	NA
MOE (N mm^{-2})											
1.5	30	110.7	62.03	12.5	85.0	136.3	0.56	NA	0.99	0.99	0.55
2.5		100.5	55.06	10.1	79.8	121.1		0.99	NA	0.99	0.47
3.5		118.1	26.38	5.7	106.5	129.7		0.99	0.99	NA	0.61
4.5		104.5	39.38	7.6	88.8	120.1		0.55	0.47	0.61	NA

*—statistically significant at $p < 0.05$, C.I.—confidence interval.

The results indicate that the strain at break increased with the increasing sliced lamellae thickness from 1.37% for 1.5 mm to 2.64% for the 4.5 mm thick sliced lamellae (Table 1). The obtained results for the strain at break were statistically significant at a 95% confidence interval for the 1.5 compared to the 3.5 and 4.5 mm and 3.5 to 4.5 mm thick sliced lamellae group comparisons. The increase in the strain at break with the increasing sliced lamellae thickness could be explained by a crack opening displacement at the crack initiation point [41]. Therefore, sliced lamellae consisting of large slicing checks experience a significant opening phase under low stress at the beginning of loading. Hence, ascertaining the effect of clamping devices and specimen geometry should be further evaluated to validate the measurements' accuracy. Other potentially significant variations in the sliced lamellae properties impacting the results may be due to various factors such as raw material properties, drying, and slicing parameters, which were beyond the current study's experimental design limitations.

The impact of the slicing thickness on the MOE perpendicular to the grain illustrates a somewhat independent variation (Figure 2 and Table 1). The obtained MOE of 110.7 N mm^{-2} for the 1.5 mm thick sliced lamellae was about six-fold lower than the reported 0.5 mm thick beech sliced lamellae results [6], and about eight times lower than oak solid wood reported values [42]. These aspects reiterate plain-sliced oak lamellae's significantly diminished stiffness due to slicing check damage.

Overall, plain-sliced oak lamellae's mechanical response behaviour resembles a quasi-brittle material, similar to solid wood. The most commonly identified stress–strain curves are shown in Figure 3. The stress–strain curves can be generally characterised by a nearly linear increase over the test course, with some specimens exhibiting a plastic strain behaviour during loading, followed by a continuous linear stress–strain increase (Figure 3 right). A possible reason for this behaviour may lie in the crack opening phase, followed by a fibre-bridging effect [1].

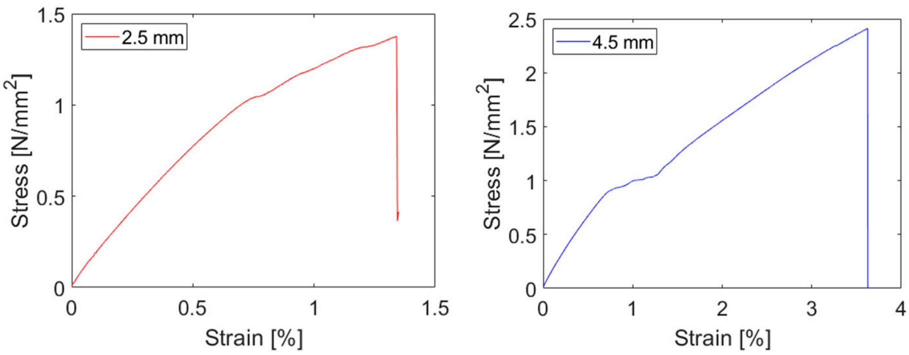

Figure 3. Examples of most common stress–strain curves observed on oak sliced lamellae; elastic followed by plastic deformation (**left**) and elastic with plastic strain mid-deformation (**right**).

3.2. Slicing Check Characteristics

The mean check depth ratio per studied thickness group and examples of the slicing checks' appearance are presented in Figure 4. The check depth ratio decreased with the increasing sliced lamellae thickness, i.e., 68% for the 1.5 mm thick sliced lamellae to 50% for the 4.5 mm thick sliced lamellae. The results indicate a negative correlation between check depth ratio and the strength properties, MOR, and strain at break (Figure 4).

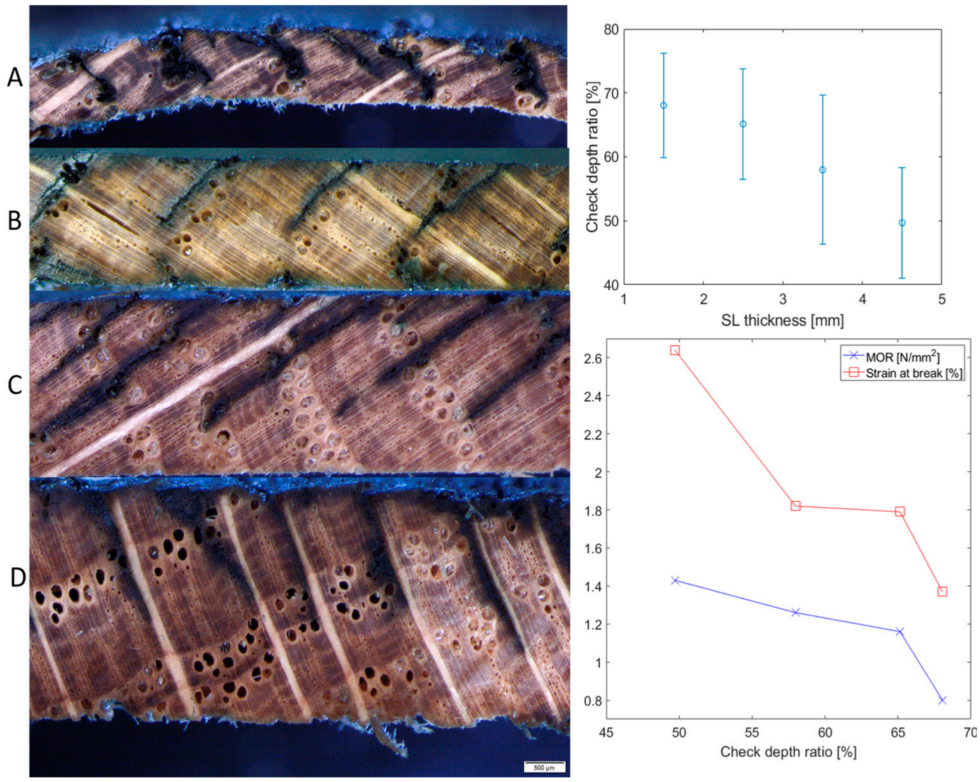

Figure 4. Example of slicing checks highlighted by a stain for (**A**) 1.5 mm, (**B**) 2.5 mm, (**C**) 3.5 mm, and (**D**) 4.5 mm thick oak sliced lamellae (left); mean check depth ratio for the evaluated SL thicknesses (upper right) and mean MOR and strain at break as functions of the check depth ratio (lower right).

Extensive slicing checks when slicing oak species may be mainly attributed to the presence of multiseriate rays that constitute stress–concentration areas during slicing [4,14]. Additionally, large earlywood vessels constituting regions of low mechanical properties facilitate crack propagation [40,43]. Overall inefficiencies in oak species wood plasticisation due to anatomical characteristics, e.g., tyloses [15], may also contribute to extensive slicing checks. If plain-sliced oak lamellae are used for structural applications, the middle range of the selected thickness groups could be beneficial, i.e., 2.5–3.5 mm. Lamellae slicing at 4.5 mm and above would provide only marginal benefits in terms of yield and productivity when compared to sawn solid wood while the decreasing material mechanical properties significantly.

Hence, the use of oak sliced lamellae for structural applications is rather unlike; therefore, the current study's results could benefit a more common use for decorative products such as flooring and furniture panel production. Understanding a raw material's most critical mechanical properties can facilitate further testing method development and product optimisation. Further studies should ascertain the impact of sliced lamellae thickness on surface checking in sliced-lamellae-based finished products. A possible impact of sliced lamellae thickness on surface checking could enable the use of mechanical properties, e.g., MOR and strain at break, as predictors for the defect occurrence. The benefit of using mechanical properties as a quality control method is due to the potential correlation between static and dynamic methods and the use of non-destructive means for the latter.

3.3. DIC Analysis

The DIC analysis revealed more insight into the fracture behaviour of the tested sliced lamellae. Figure 5a–d illustrate a common fracture mechanism depicting stress concentration around the most extensive slicing checks. A fracture occurred in the radial–longitudinal plane. The strain maps in Figure 5(Ia,IIa) show the detection of significant strain corresponding to several slicing checks at the beginning of loading. By the end of the loading, as observed in Figure 5(Ib,IIb), the failure would occur following extensive slicing checks.

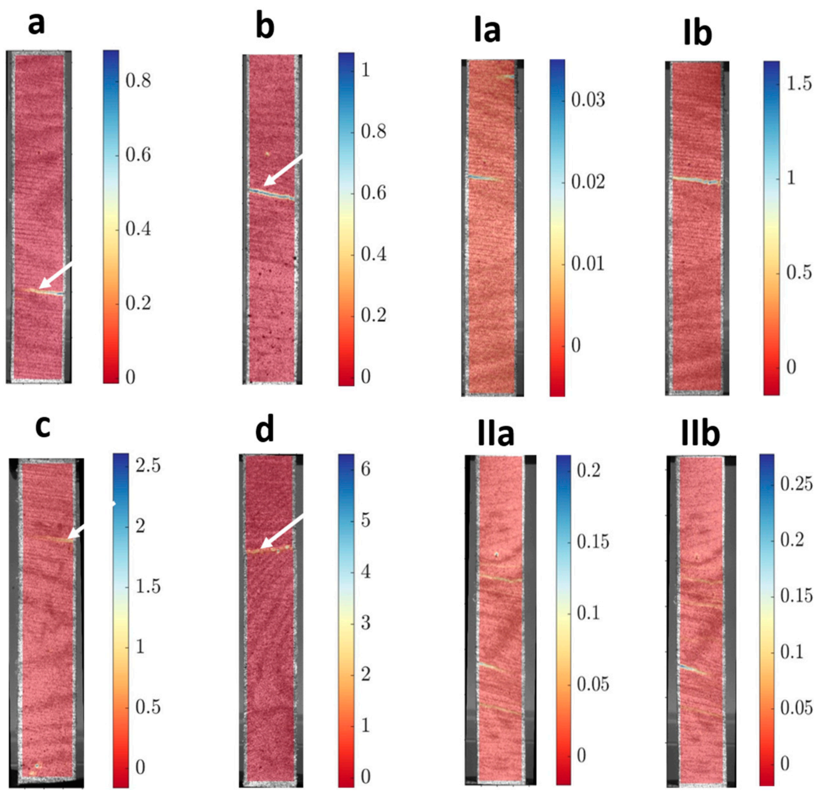

Figure 5. Principal maximal strain for (**a**) 1.5 mm, (**b**) 2.5 mm, (**c**) 3.5 mm, and (**d**) 4.5 mm thick sliced lamellae (arrows indicate fracture area); (**Ia**,**IIa**) strain concentration around areas of slicing checks at the beginning of loading and (**Ib**,**IIb**) at the breaking point.

Generally, principal maximal strain tends to increase with increasing sliced lamellae thickness (Figure 5), similar to the strain rate from experimental data. The method should be further explored to enable robust and interchangeable results between the two methods.

4. Conclusions

Oak sliced lamellae are a quasi-brittle material, affected significantly by slicing check characteristics. The novelty of this study is highlighted by the correlation between the check depth ratio, which is influenced by the lamella thickness, and the sliced lamellae strength and strain at failure. In the elastic domain, the stiffness was not significantly impacted by slicing check characteristic variations.

The obtained mechanical properties for the oak sliced lamellae indicate inferior mechanical performance compared to other reported species and corresponding solid wood species. The DIC method has shown that slicing checks are sliced lamellae's stress concentration and ultimate failure areas. The DIC strain data facilitated the interpretation of failure mechanisms in sliced lamellae.

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Conflicts of Interest: The authors declare no conflict of interest.

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