Unsound defect volume in hardwood pallet cants

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Abstract

A study was conducted to determine the percentage of unsound defect volume to sound/clear wood in pallet cants at selected sawmills in Virginia and West Virginia. Splits, wane, shake, holes, decay, unsound knots, bark pockets, and mechanical defects were all considered to be unsound. Data were collected from seven Appalachian area sawmills for four hardwood species: red oak (*Quercus rubra*, L.), white oak (*Quercus alba*, L), yellow-poplar (*Liriodendron tulipifera*, L.), and basswood (*Tilia americana*, L.). White oak and yellow-poplar had higher percentages of unsound defect volume compared to red oak and basswood. Regardless of the mills and species, splits accounted for the highest percentage of defect volume per cant. Decay, bark pockets, shake, and holes also contributed significantly to the total defect volume. The majority of unsound defects in white oak and red oak consisted of holes, decay, splits, and shake. Ninety percent of the cants had defect volumes less than 10 percent, and 2 percent of the cants had unsound defect volumes higher than 30 percent. This study suggests that cants can be pre-sorted and some even culled before processing into pallet parts, which ultimately will reduce the processing cost and produce high quality, longer-lasting pallets.

Every year, over 400 million new wood pallets (**Fig. 1**) are manufactured in the United States, consuming 4.5 billion board feet (BF) of hardwood lumber (Bush et al. 1997). Annually, about 30 to 40 percent of sawn hardwoods goes into the manufacture of wood pallets. Cants are the primary raw material for producing pallet part components, such as stringers (the structural center members that support the load) and deckboards (the top and bottom members that provide dimensional stability and product placement). Usually, the cants are produced from small logs or the center portion of sawlogs, which have a higher percentage of defects than the outer portions of the sawlogs. Use of higher quality cants should result in higher part yields, a higher grade of pallet parts, and ultimately a longer pallet life cycle. Also, if the quality of pallet material is improved, there is a greater possibility of promoting reuse of discarded pallet parts. The grading, sorting, and culling of cants prior to manufacturing pallet parts should reduce processing costs and improve pallet part quality. An economic analysis by Schmoldt et al. (1993) has demonstrated profit potential for grading, sorting, and culling pallet parts.

The grading of a cant is a complex task that requires the accurate measurement of all objectionable defects. An attempt has been made to grade pallet parts using an automated ultrasound scanning system (Kabir et al. 2002, Schmoldt et al. 1996). That study showed that the ultrasound scanning system is able to successfully detect, locate, and classify defects. A similar ultrasound system could be possible to

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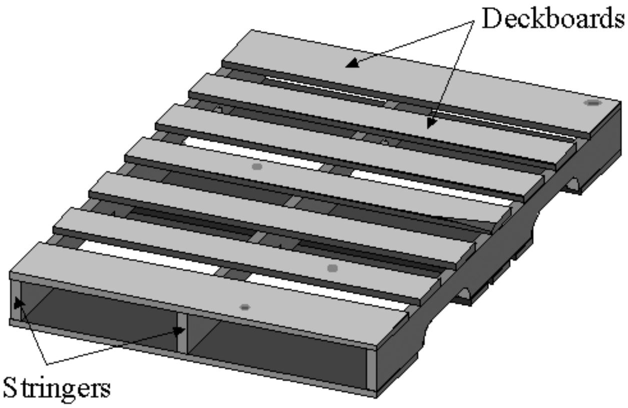

Figure 1. — A typical 48- by 40-inch pallet with stringers and deckboards.

Table 1. — Definitions of unsound defects.

Defect type	Definition
Split	A separation along the grain caused by drying stresses.
Unsound knot	A knot not solid across its face or else softer than the surrounding wood, due to decay of other defects.
Wane	Bark or lack of wood usually occurring along the edge of the cant.
Shake	A separation along the grain, the greater part of which occurs between the rings of annual growth.
Hole	A void caused by insects or any other means.
Decay	The decomposition of wood substance by fungi.
Bark pocket	A bark-filled blemish in the cant.
Mechanical	A defect caused by anything but natural circumstances.

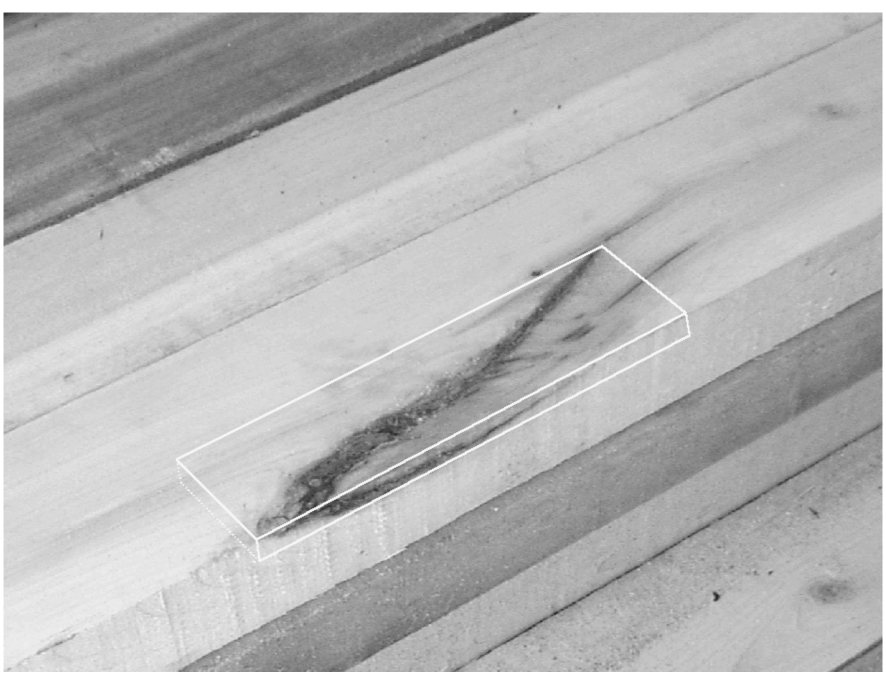

Figure 2. — Typical defect measurement on a yellow-poplar cant.

grade, sort, and cull pallet cants. Furthermore, automated cant-to-parts processing systems could be developed to maximize yields and quality.

Mitchell (1999) proposed a single cant grade based on a minimum volume of sound/clear wood. Initially, that study was aimed at developing three possible cant grades based on the percentage of unsound material. Cants were graded No. 1 for 0 to 15 percent unsound wood, No. 2 for 16 to 30 percent, and No. 3 for over 30 percent unsound defects (Anon. 1999). The percentage of unsound material was calculated by taking volumetric measurements of defects, such as splits, unsound knots, wane, shake, insect holes, rot, and decay. The definitions and descriptions of each defect type are given in **Table 1**. They are found in the National Hardwood Lumber Association (NHLA) grading rules (Anon. 1994). While assuming three cant grades, mill samples indicated that nearly 90 percent of all cants were either grade No. 1 or No. 2. Also, the most significant reduction in pallet part yield occurred between grades No. 2 and No. 3. Therefore, a single grade consisting of a maximum allowable unsound defect volume of 30 percent was recommended. The characterization of these defects may play an important role for grading cants, both manually and by automated systems. This paper presents the results of a study aimed at characterizing the unsound defect volume of cants for several hardwood species.

Materials and methods

Seven sawmills were selected in Virginia and West Virginia to participate in this study. Mill selection was based on convenience of travel, type of sawmill operation, and willingness to participate. A crew of four people, working in groups of two, randomly selected and measured individual cants as they came off the green chain. We also randomly selected stacks of cants recently processed and ready to be shipped for inspection and measurement. The species studied were red oak, white oak, yellow-poplar, and basswood, depending on the availability in the sawmill. The species and dimensions (length, width, and height) were recorded for each cant. Cants were 10 to 16 feet in length, 6 inches in width, and 4 inches in thickness. Defect data were then collected for any occurrence of splits, wane, shake,

Table 2. — Number of individual cants sampled at each sawmill.

	Number of cants sampled				
Mill	Red oak	White oak	Yellow-poplar	Basswood	Total
1	0	98	0	0	98
2	49	0	0	49	98
3	154	0	83	0	237
4	52	0	0	0	52
5	0	77	0	0	77
6	58	65	0	0	123
7	0	49	89	0	138
Total	313	289	172	49	823

Table 3. — Total volume of cants sampled at each sawmill.

	Volume of cants sampled				
Mill	Red oak	White oak	Yellow-poplar	Basswood	Total
	- - - - - - - - - -	- - - - - - - - - -	(BF)	- - - - - - - - - -	- - - - - - - - - -
1	0	6,069	3,218	0	9,269
2	4,470	0	0	3,549	8,019
3	9,515	0	6,003	0	15,519
4	4,068	0	0	0	4,068
5	0	5,664	0	0	5,664
6	5,959	7,092	0	0	13,051
7	0	4,365	8,922	0	13,287
Total	24,012	23,190	18,143	3,549	68,877

Table 4. — Average unsound defect percentage by defect type for all mills.

	Average defect percentage per cant								
Species	Split	Wane	Shake	Hole	Decay	Unsound knot	Bark pocket	Mechanical defect	Total
Red oak	2.04	0.16	0.34	0.47	0.58	0.08	0.19	0.02	3.89
White oak	1.39	0.22	0.37	0.65	1.62	0.02	0.57	0.09	4.92
Yellow-poplar	1.92	0.04	0.30	0.08	1.62	0.05	0.27	0.05	4.32
Basswood	1.43	0.13	0.00	0.00	0.23	0.04	0.33	0.11	2.28

holes, rot, decay, unsound knots, bark pockets, and mechanical defects. Defects were identified and classified according to the NHLA grading rules (Anon. 1994). An imaginary rectangular solid box was visualized around each defect, such that the entire unsound area was encompassed. Length, width, and height dimension measurements were taken for the imaginary solid. All the measurements were taken from the top or bottom wide face of the cant, even if the defect was located on the narrow face. If a defect was only visible on one face of the cant, the dimension of the hidden face was estimated. **Figure 2** shows a typical defect measurement on a cant.

Results and discussion

The number of cants sampled at each mill and for each species is shown in **Table 2**. There were 823 cants studied for defect characterization, the majority of which (73%) were oak. This is fairly representative of the pallet cant production for the region. **Table 3** shows the total volume (in BF) of cants sampled at each mill for each species. The largest volume of cants was studied at Mill 3 (15.5 MBF) while the smallest volume was studied at Mill 4 (4.1 MBF). Red and white oak accounted for about 69 percent of the total cant volume.

Table 4 shows the average unsound defect percentage for each defect type and species. White oak had a higher percentages of wane, holes, and bark pockets compared to other defect types. The majority of unsound defect volume found in yellow-poplar was comprised of splits and decay. Overall, basswood had fewer defects than the other wood species. Regardless of the mills and species, the largest volume-occupying defect was splits, followed by decay (**Fig. 3**). Bark pockets, shake, and holes were the next most abundant defects, and each contributed approximately the same amount to the total defect volume. **Figure 4** shows the average unsound defect percentage for each species over all mills. White oak had the highest (4.92%) average percentage of unsound material while basswood had the lowest (2.28%).

The average amount of unsound defect volume per cant for each mill is illustrated in **Figure 5**. Mill 4 had the lowest average defect volume (2.03%), but also had the smallest sample size (**Fig. 5**; **Table 2**). It is possible that this number could fluctuate if more cants were sampled. Mill 5 had the largest average defect percentage per cant with 6.98 percent, which is still a relatively small amount. The difference between the maximum and minimum defect volume is 4.95 percent, which is equivalent to a 6-inch-long section on a 4-inch by 6-inch by 10-foot cant. Since this is such a

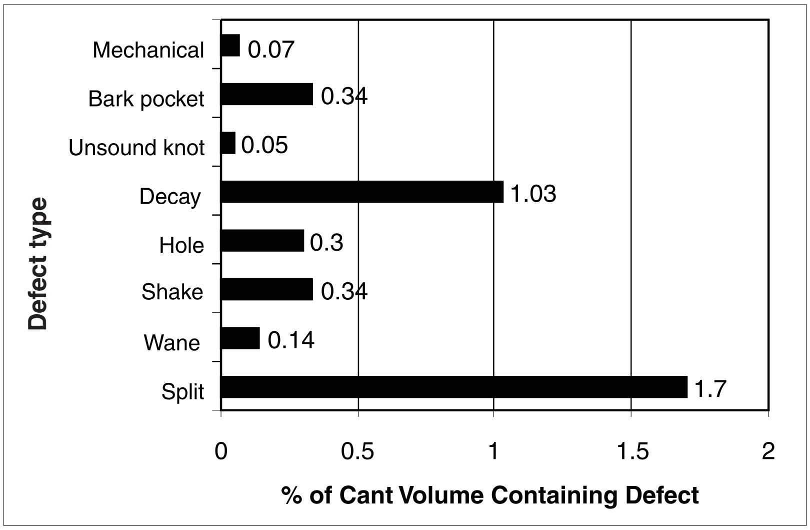

Figure 3. — Average unsound defect percentage per cant for all species.

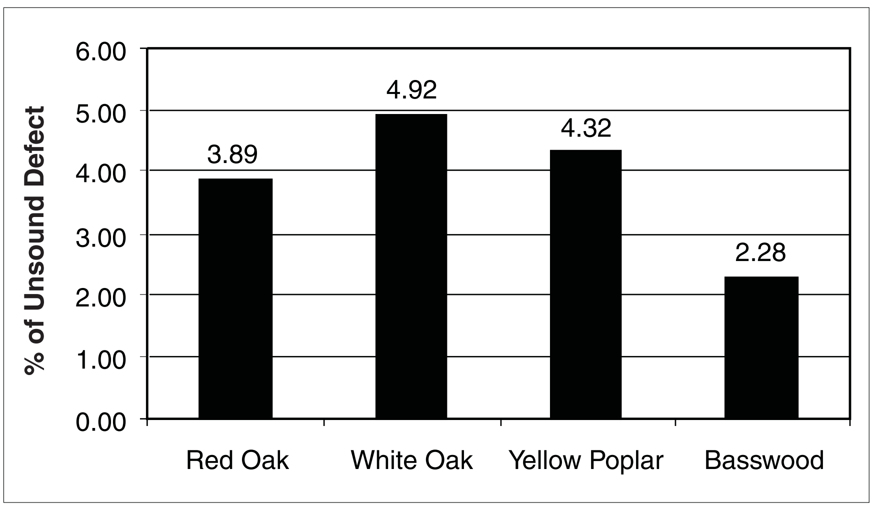

Figure 4. — Average unsound defect percentage for individual cants.

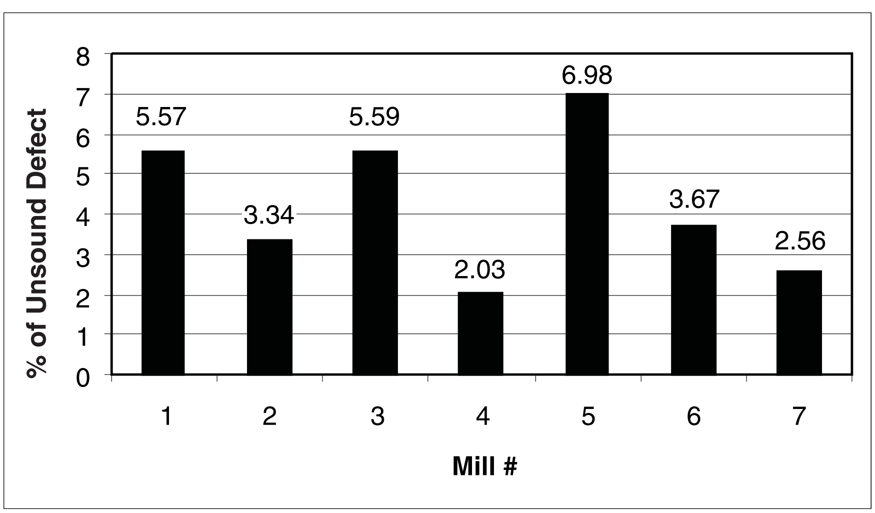

Figure 5. — Average unsound defect percentage per cant, by mill, for all species.

small difference, it should not be implied that one mill's cants are significantly better than another's. One reason for the difference might be that some mills appeared to remove more defects when trimming poor cants with double trim saws. Furthermore, some mills sent highly defective cants to the chipper. Another possible reason for the discrepancies is that multiple species were sampled at all mills with the exception of mills 4 and 5. Certain species might be more prone to certain defect types because of their physical and chemical properties. For example, white oak might be more susceptible to insect damage than yellow-poplar. A more reasonable comparison between mills and species can be seen in **Figure 6**.

All cants were classified based on the total defect percentage and the results are presented in **Figures 7** and **8**. Regardless of mills or species, 90 percent of all cants have less than 10 percent unsound defects while only 10 percent of the cants have more than 10 percent unsound defect volume. It is also clearly shown in **Figure 7** that only 2 percent of the cants have an unsound volume greater than 30 percent. Since, this was the proposed cutoff for a minimum pallet cant grade (Mitchell 1999), only 2 percent of the cants sampled would have been considered below grade. **Figure 8** shows the same information broken down by species.

Conclusions

For all species sampled, splits exhibited the highest percentage of defect volume, followed by decay. Bark pockets, shake, and holes were the next most abundant defects. White oak showed the highest percentage of unsound defects whereas basswood exhibited the lowest. The average unsound defect volume percentage per cant varies from mill to mill and for each species. Ninety percent of the cants studied were found to have less than 10 percent of total unsound volume, and only 2 percent of the cants had more than 30 percent unsound volume.

This study suggests that cants can be pre-sorted for sales to pallet producers with some even culled in the sawmill processing. This would reduce pallet processing costs and allow higher quality and longer lasting pallets to be produced. The cants with more than 30 percent unsound volume should be chipped at the sawmill due to the low yield of

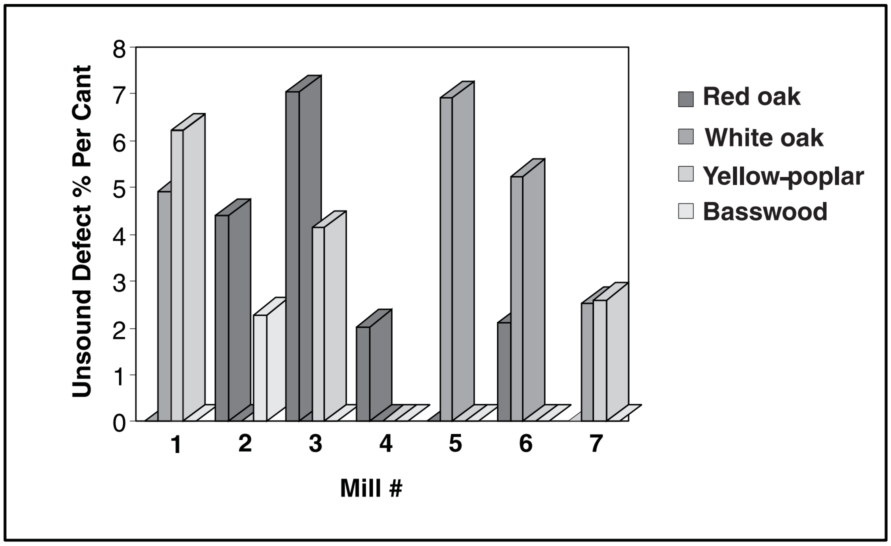

Figure 6. — Average unsound defect percentage per cant, by mill and species.

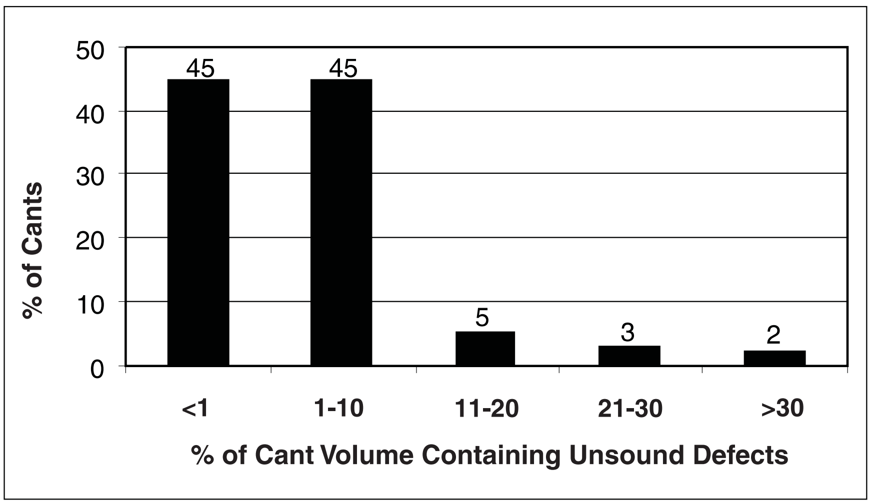

Figure 7. — Classification of cants based on unsound defects for all mills and species.

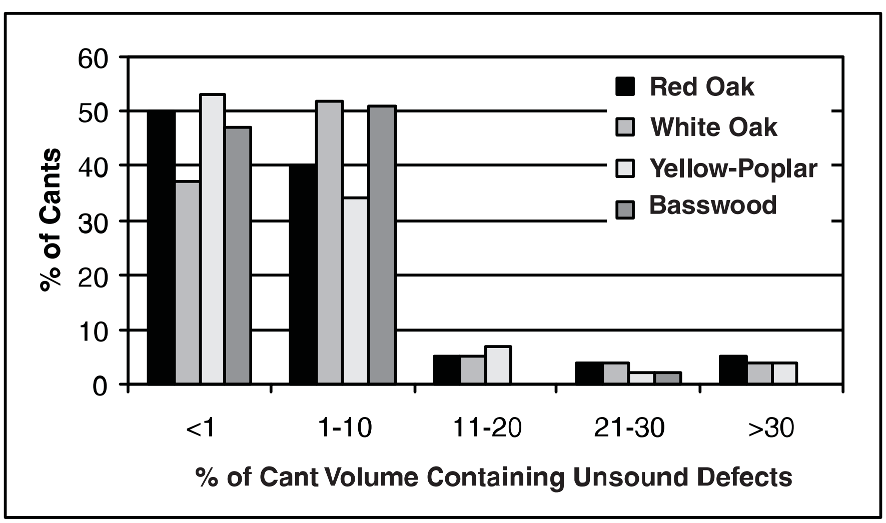

Figure 8. — Classification of cants based on unsound defects , by mill and species.

usable parts if processed to pallet parts as noted by Mitchell (1999).

The results from this study can be used by scientists developing automated grading and processing systems for pallet cants (Kabir et al. 2001). Success of these systems will be determined by their ability to recognize the unsound defects in the cants. The scientists and system developers need to know the frequency of unsound defects to focus their efforts on highly occurring defect types.

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