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The Impact of the Weather Conditions on the Quality of Birch Veneer Logs During Winter Harvesting

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Abstract. The external characteristics of a tree give the only clue to the quality of veneer log obtained in harvesting. When the tree is bucked into veneer logs, the cross sections at the butt and top ends of these assortments may provide additional indicators of the quality. Thus, it becomes important to study the abnormalities that can be seen on the end surface of the veneer logs such as heart shakes, and to correlate the occurrence of these imperfections with the quality of veneer that is produced from the veneer log.
Therefore, the purpose of this study was to: (1) identify and measure heart shakes length, width and depth in wood in all investigated veneer logs diameter groups: 180-249mm; 250-299mm, 300<mm in the period of storage, (2) identify the factors that could initiate heart shakes in veneer logs in the period of storage (number of storage days, weather temperature, moon phases, relative humidity) in all diameter ranges, (3) by analysing the results to work out the recommendations to improve the forest management in forest stands when veneer logs are manufactured.

Keywords: Bertula pendula, Bertula pubescens, veneer logs, heart shake.

1. INTRODUCTION

There has been an increasing demand from industry for suitable veneer grade rules for *Bertula pendula Roth*. and *Bertula pubescens Ehrh.* specie used in the manufacture of veneer. *Bertula pendula Roth*. and *Bertula pubescens Ehrh.* are short lived, relatively small broadleaved trees that occur throughout most of Europe, particularly in northern regions. Birch trees provide the predominant hard wood source in northern Europe, and some varieties of *Bertula pendula Roth* peroduce highly priced veneers, while *Bertula pubescens Ehrh.* is mostly used for pulp and fire wood.

Bertula pendula Roth. is medium-sized tree, growing up to 30m, while *Bertula pubescens Ehrh.* is relatively shorter, rarely growing beyond 20m and less towards its northern range limits [3], [4]. *Bertula pendula Roth*. and *Bertula pubescens Ehrh.* occur naturallty throughout most of Europe up to central Siberia. Given their wide distribution, these two birches (Figure 1) show a high morphological variability and different subspecies and varietals have been described [6]. Birches are most abundant in the boreal zone of northern Europe, where thay can co-dominate or dominate in late-successional vegetation.[10]. Species are not wind resistant. Birch provides the commercially most important source of hardwood in northern Europe and is often an important component in conifer plantations, such as those of *Pinus sylvestris* and *Picea abies.* The value and yield of these veneer logs stands with large stump diameter dimensions have been adversly affected by the presence of *heart shakes* in many of trees.

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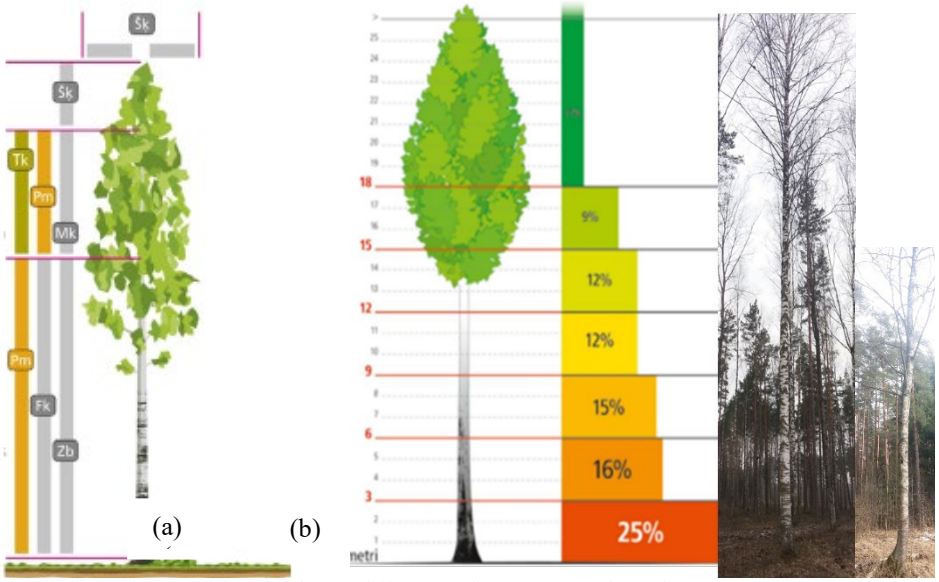


Fig.1. Roundwood assortiments harvested from birch stem different quality zones (a), where Fk – veneer logs, Zb – sawlogs, Mk – fire place firewood, Pm, – pulpwood, Tk – technological wood/ firewood, Šķ - wood residuals for chips manufacturing. Distribution of *Bertula pendula Roth*. and *Bertula pubescens Ehrh.* trunk by volume (b).

Heart shake are found in all veneer logs. Most of the heart shakes are located in the butt assortments, extending downward into the stump

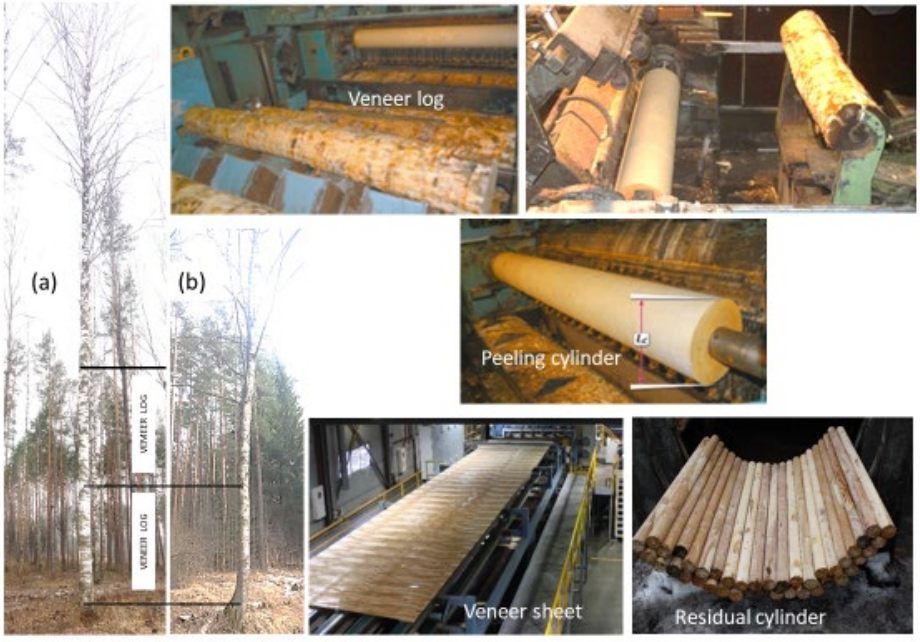


Fig.2. Harvested veneer logs and veneer peeling technological process, where: (a)- *Bertula pendula Roth* stem, (b) - *Bertula pubescens Ehrh.* stem.

Heart shake: A group of splits or split radiating from the pith or centre of the tree in the form of star or as a single spit perpendicular to the growth rings. Star shakes are usually formed due to extreme heat or severe frost during the tree's growth. In some instances it is restricted to the heart center of a tree, in others it appears to enlarge progressively with heartwood formation and then extends across the heartwood zone. Heart shake may be disregarded as a defect in veneer logs when contained within the flange area of the lathe chuks which diameter is 70mm. When the split extends beyong the rim of the chucks, due allowance should be made for cull, since shorts only can be produced from the residual cylider. Althought this is a naturally occuring defect possibly caused by frost or wind stress, shakes can also occur on impactat the time of felling and because of shrinkage in the log before the technological process of converting veneer logs to veneer sheets.

Bertula is the third most commercially important tree species in Latvia (27.9% from the area) [8]. The statistics [6], [7], [9] show that the form of the birch stem between 1.5m above the stump cut and the height of 4m is close to cylinder- the taper of 2.5 m long log is only slighty above 3cm and the differences between the forests on dry mineral soils and other forests are not significant.

Most veneer and plywood plants have some method of classifying logs by grade to control the purchase price paid for logs bought on the open market. Such log-grading systems have been developed by experience and are dependent to a large extent upon the ability of the grader and his knowledge of veneer grades and yields required for the specific product produced by his company. These rule-of-thumb grading systems are often very inaccurate and inconsistent. Manufactures of both high and low grade veneer recognize the need for a veneer log grading system that can be easily and uniformly applied. Therefore, the new actualized and systematizated, scientifically approved findings related to birch physical characteristics are needed to improve the technological process of converting veneer logs to veneer sheets.

The goal of this study was to synthesize the existing experience and knowledge about birch veneer logs quality requirements and to work out the recommendations to improve the forest managment in forest stands, where *Bertula pendula Roth*. and *Bertula pubescens Ehrh.* stands are growing.

The following objectives were set to achieve the study goal:

To determine the distribution of heart shakes within and among trees, where the physical characteristics of the trees or any environmental factors were associated with heart shakes,

To identify and measure heart shakes lenght, width and depth in wood in all investigated veneer logs according to diameter groups: 180-249mm; 250-299mm, 300<mm.

To identify the factors that initiate heart shake in veneer logs at the period of storage (number of storage days, weather temperature, moon phases, relative humidity) in all diameter groups,

To measure heart shakes extending downward into veneer log depth, where the width in the widest place is greater than 2mm.

By analysing the results to work out the recommendations to improve the forest managment in forest stands when veneer logs are manufactured.

II. MATERIALS AND METHODS

2.1. Field Measurements

Sampling stumps of *Bertula pendula Roth*. in different forest types and age class felling areas to harvest birch roundwood assortiments according to the specification (Table 1.)

Measuring the end surface diameters, the heart shakes width,, length and depth of stocked veneer logs according to the scheme (Figure 3; 4) [5].

Checking moon phase, relative humidity, weather temperature, storage days after harvesting on the day of measurement.

Checking the actual heart shakes distribution extending downward into the veneer log according to the scheme (Figure 2; 4) to verify the adequacy of the heart shakes depth measurement methodology

2.2. Statistical Analyses

The sequental data were collected and analysed:

Block area-Forest block-Forest compartment; Area (ha); Stock nr; Average tree volume (m^3); Stock (m^3); County; Coordinates X/Y; Forest type; Age class; Age decade; Species composition; Sampled Birch trees (pcs.); Mean height (m); Mean diameter (cm); Harvested volume (m^3/o.b.); Harvested volume (m^3/u.b.); Harvested assortiments ((pcs.// m^3/u.b. //total lenght (m)); Mean heart shake length/ Stdev (mm); Mean heart shake width/ Stdev (mm)

III. RESULTS AND DISCUSIONS

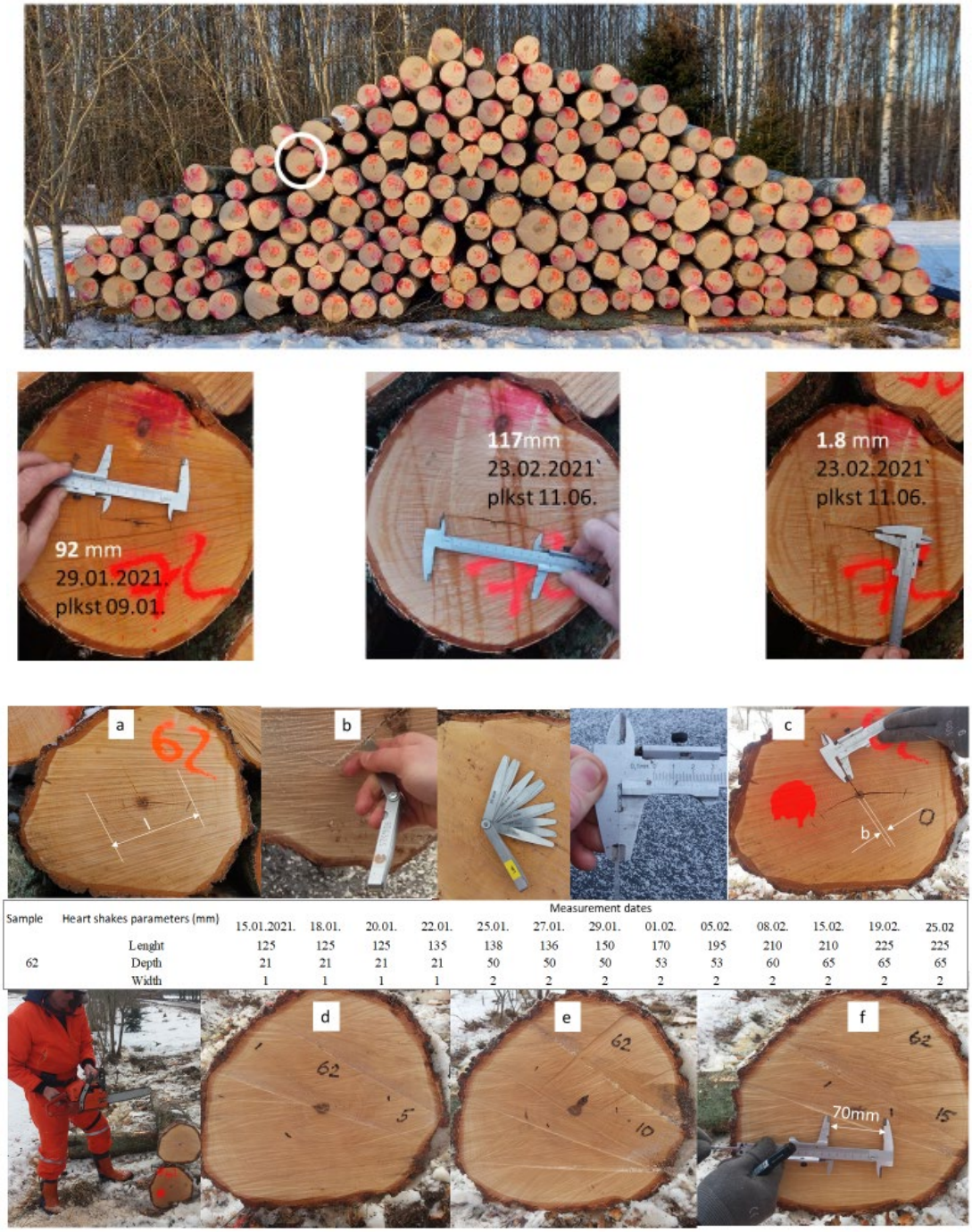
In the Vidusdaugava Logging Region, a felling area (502-247-20) was selected, where 247 birch veneer logs were prepared and stacked in the stock JD1134_01 (Table1).

TABLE 1. CHARACTERISTICS OF INVESTIGATED FOREST SITE TYPES AND HARVESTED BIRCH ASSORTMENTS

Parameter	**Data**	
Block area-Forest block-Forest compartment	502-247-20	309-238-30
Area (ha)	1.85	3.01
Stock identification	JD1134_01	DE2073_01
Average tree (m^3)	0.73	0.94
Stock (m^3)	527.81	642.96
Country	Koknese	Daugavpils
Parish	Nītaure	Nīcgale
Coordinates X/Y	586300/293224	652495/213459
Forest type	Mercurialiosa mel.	Oxalidosa
Age class	Mature stand	
Age decade	80	
Species composition	8 *Bertula 1 P.Abies* 1 *P.tremula* 72	5 *Bertula 4 P.tremula 1 P.Abies 76*
Specie	04-*Bertula*	
Age (years)	72	76
Trees(pcs.)	489	782
Mean height (m)	24	26
Mean diameter (cm)	33	29
Volume (m^3/o.b.)	203.473	372.62
Volume (m^3/u.b.)	180.652	332.25
Assortiment specification ((top diam.(mm)/ butt diam. (mm)/ nominal lenght (cm)/ oversize (mm))		
Veneer logs	185/700/270/5	
Packing case timber	120/500/240/10	
Fire place firewood	100/400/300	
Pulpwood	60/700/270;300	
Firewood	50/800/270;300	
Harvested assortiments((pcs.//m^3/u.b.// total lenght (m))		
Veneer logs	491/64.248/1358.18	785/115.96/2165.55
Packing case timber	983/61.738/2473.59	1132/84.81/2842.09
Fire place firewood	7132/36.803/2149.71	824/47.34/2480.07
Pulpwood	374/17.371/1127.54	984/66.50/2940.24
Firewood	27/0.492/81.44	983/17.70/277.73
Average tree diameter DBH (cm)	219	
Average tree volume (m^3/o.b.)	0.416	
Average tree volume (m^3/u.b.)	0.369	

In the South Latgale logging region, a felling area (309-238-30) was selected, where 223 birch veneer logs were prepared and stacked in the stock DE2073_01 (Table 1).

Measuring of the heart shakes distribution on the end surfaces of the veneer log sample according to the storage days after harvesting and the actual depth distribution were done according to the scheme (Figure 3).



Sample	Heart shakes parameters (mm)	Measurement dates												
		15.01.2021.	18.01.	20.01.	22.01.	25.01.	27.01.	29.01.	01.02.	05.02.	08.02.	15.02.	19.02.	25.02
62	Lenght	125	125	125	135	138	136	150	170	195	210	210	225	225
	Depth	21	21	21	21	50	50	50	53	53	60	65	65	65
	Width	1	1	1	1	2	2	2	2	2	2	2	2	2

Fig. 3. Measuring of the heart shakes distribution on the end surfaces of the veneer log sample according to the storage days after harvesting, where a – heart shake length (using caliper), b- heart shake depth (using 0.1mm thick caliber), c-heart shake width (using caliper), d/ e/f - heart shake length and the actual depth distribution 50 mm /100mm/150mm from the end surface.

Checking the actual heart shakes distribution extending downward into the veneer log were done according to the scheme (Figure 4).

Fig. 4. Heart shakes distribution extending downward into the veneer log, where:
(I-I); (II-II); (III-III); (IV-IV); (V-V) – end surface of veneer log; h- deep of the heart shake; b- width of the heart shake; l- actual length of the heart shake; d-diameter (70mm) of the residual cylinder; a- end point of the heart shake.

Characteristics of measured heart shakes depend on veneer diameters are given (Table 3; 4)

TABLE 3. CHARACTERISTICS OF MEASURED HEART SHAKES DEPENDING ON VENEEER DIAMETERAS IN THE STOCK JD 1134_01

Parameters	Results							
Measurement dates/ storage days after harvesting	26.01.2021./3	29.01./6	01.02./9	04.02./12	09.02./17	15.02./23	20.02./28	24.02./32
Moon phase	Growing moon	Full moon	Descending moon	Descending moon	Descending moon	Growing moon	Growing moon	Growing moon
Relative Humidity (%)	87	75	71	80	86	63	81	90
Weather temperature (^{0}C)	1	-3.5	-1	-9	-12	-7	-8	3
Diameter group (mm) 180-249 (215pcs.)								
Mean heart shake lenght/Stdev (mm)	56/37	62.8/39.1	63/39.7	56/37	56/37	56/37	56/37	56/37
Mean heart shake widtht/Stdev (mm)	0.7/0.4	0.7/0.4	0.7/0.4	0.7/0.4	0.8/0.6	0.8/0.6	0.8/0.6	0.8/0.6
Diameter group (mm) 250-299 (22pcs.)								
Mean heart shake lenght/Stdev (mm)	56.1/38.5	62.9/40.2	63.1/40.6	56.1/38.5	56.1/38.5	56.1/38.5	56.1/38.5	56.1/38.5
Mean heart shake widtht/Stdev (mm)	0.7/0.4	0.7/0.4	0.7/0.4	0.7/0.4	0.8/0.6	0.8/0.6	0.8/0.6	0.8/0.6
Diameter group (mm) 300< (10 pcs.)								
Mean heart shake lenght/Stdev (mm)	56.6/37.7	63.4/39.1	63.6/39.5	56.6/37.7	56.6/37.7	56.6/37.7	56.1/37.7	56.6/37.7
Mean heart shake widtht/Stdev (mm)	0.7/0.4	0.7/0.4	0.7/0.4	0.7/0.4	0.7/0.5	0.7/0.5	0.8/0.6	0.8/0.6

TABLE 4. CHARACTERISTICS OF MEASURED HEART SHAKES DEPENDING ON VENEEER DIAMETERAS IN THE STOCK DE 2073_01

Parameters	Results												
Measurement dates/storage days after harvesting	15.01.2021./1	18.01./4	20.01./6	22.01./8	25.01./11	27.01./13	29.01./15	01.02./18	05.02./22	08.02./25	15.02./33	19.02./37	25.02./43
Moon phase	Growing moon	Growing moon	Growing moon	Full moon	Full moon	Full moon	Full moon	Descending moon	Descending moon	Descending moon	Growing moon	Growing moon	Growing moon
Relative Humidity (%)	78	86	86	88	92	97	93	89	89	78	84	73	85
Weather temperature (^{0}C)	-17	-13	-12	1	1	1	-3	-3	-9	-10	-9	-13	8
Diameter group (mm) 180-249 (148 pcs.)													
Mean heart shake lenght/Stdev (mm)				20/62.5	35/38.47	45/38.68	45/39	50/40.83	80/45.12	120/50.40	120/51.38	120/52.46	101.5/52.77
Mean heart shake widtht/Stdev (mm)				0.5/0.45	0.5/0.45	0.5/0.44	0.5/0.44	0.5/0.47	0.5/0.47	0.5/0.58	0.5/0.63	09.5/0.63	0.75/0.63
Diameter group (mm) 250-299 (68 pcs.)													
Mean heart shake lenght/Stdev (mm)			29.3/44.1	73.8/40.8	74.7/39.3	81.5/39.1	94.2/41.1	103.0/46.3	103/54.6	103/56.1	103/56.1	103/58.2	100.6/57.1`
Mean heart shake widtht/Stdev (mm)			0.5/0.3	0.7/0.3	0.7/0.3	0.7/0.5	0.7/0.5	0.7/0.5	0.7/0.5	0.7/0.5	0.7/0.5	0.7/0.6	0.7/0.6
Diameter group (mm) 300< (7 pcs.)													
Mean heart shake lenght/Stdev (mm)	147/101.5	152/100.3	152/100.3	152/100.3	115/82.4	117/81.2	116/81.2	123/78.3	135/76.1	149/94.3	153/99.7	157/105.1	156/105.3
Mean heart shake widtht/Stdev (mm)	1/0.6	1/0.6	1/0.6	1/0.6	1/0.7	1/0.7	1/0.7	1/0.7	1/0.7	1/0.7	1/0.9	1/0.9	1/0.9

IV. CONCLUSIONS AND RECOMENDATIONS

According to the investigation results and the statistical analyses of the occurrance of heart shake [1], [2] in *Pinus elliotti* trees revealed that there were no important differences among geographic locations in the occurance of heart shakes. No important relationships existed between any of the location or soil variables studied and the measures of the occurance of heart shakes or of their linear guantities. Therefore, on this basis such conclusions would also be plausible for *Betula pendula Roth*. and *Bertula pubescens Ehrh.* species.

The heart shakes distribution process depends on diameter of veneer logs and weather temperature at the period of storage. Heart shakes appear in veneer logs (diameter group 300<mm) in the first day after harvesting, in veneer logs (diameter group 250-299mm) in period of 3rd-6th day aftter harvesting, in veneer logs (diameter group 180-249mm) in period 3rd-8th day after harvesting.

Heart shakes length decreases till 2.33 % in case where is a rappid weather temperature change from (-)13 to (+)8°C in diameter group 250-299mm, 15.83 % in the case when there is a rappid weather temperature change from (-)13 to (+)8°C in diameter group 180-249mm.

Heart shakes length decreases till 11 % in the case if there is a rappid weather temperature change from (-)1 to (-)9°C in all diameter groups.

The study obtained a finding that indicates the inconsistency of the applied method in measuring the depth of cracks. The actual depth of the cracks cannot be determined with a feeler gauge. This can only be determined by cross-cutting.

The presence of a heart shake in veneer logs affects not only the quality of the veneer sheet, but also the safety of the peeling technological process if the width in the widest place is greater than 2mm and heart shake splits the veneer log side surface.

Based on the results of the study it is proposed to harvest veneer logs in length 35 cm longer compared to manufactured veneer sheets width. In this case heart shakes should not be evaluated.

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