ASPECTS REGARDING THE DETERMINATION OF LOG SECTION POSITION TO REDUCE THE CURVATURE

Timofte Adrian Ioan*, Budău Ruben*

** University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048, Oradea, Romania*

Abstract

The present paper analyses one of the most important form faults characteristic for unprocessed during industrialization, the curvature.
A mathematical model was developed for arched curvatures and also, practical solutions are proposed for frequently met situation during the sorting and splitting, namely how much of a section must be made in a curved bole which presents an overlimit curvature. The resulted piece should be in the frame of admitted tolerances.
Several tables are proposed as a helping device for wood exploitation and industry workers who are implied in wood sorting and splitting in order to diminish the losses due to bole curvature.

Key words: *curvature, wood exploitation, wood sorting, logs*

INTRODUCTION

Among the form defects of the trunk, the curvature represents one of the most encountered defects, along with saber butt, conicalness, root-swelling, ovality, forning, fluting, being the result of some growing anomalies and leading to a decrease in value of the round wood types.

The curvature represents the curving of the trunk axis in two or more plans, there being a deviation of the trunk axis from right line. It is considered to be a serious defect.

Among the form defects, the curvature is part of the axial growing defects, along with saber butt, forning, the others being defects of radial growing.

The curvature (for the same trunk) can be (Lupu, 2003):
- simple or multiple;
- all along the piece or just on one portion;
- on a single plan or on different plans.

The curvature is much more frequent at deciduous trees than at resinous, especially at the young trees. Once the growing of the curvature decreases, the trees straighten more or less.

The curvature of the trunk appears after the action of the winds, heavy loads (snow), slope of the land, special vegetation conditions, asyimmetrical top crown of the tree and so on. Generally, it appears at all the species (Beldeanu, 1999).

In order to emphasize the importance of this defect and its frequence, it is suggested the following example: at the auction of logs in June 2000 at Milova, Arad county, one of the most important international auctions in Transylvania from all points of view, organised during the last few years, the curvature being present (generally, below the critical values) in a high percentage.

Table 1

The frequency of the curved logs for different species and on types of curvature

Species	Logs	Simple curvature		Multiple curvature in the same plan		Multiple curvature in different plans	
		pieces	%	pieces	%	pieces	%
Cherry tree	216	59	27,3	14	6,5	5	4,5
Maple tree	110	24	21,8	2	1,8	1	2,9
Alder	34	5	14,7	1	2,9	-	-
Ash	24	14	58,3	1	4,2	-	-
Plane maple	6	1	16,7	1	16,7	-	-
Oak tree	17	5	29,4	1	5,9	-	-
Sessile oak	45	10	22,2	3	6,7	3	6,5
Beam tree	46	3	6,5	3	6,5	3	4,2
Beech	72	19	26,4	2	2,8	-	-
Lime tree	79	-	-	2	2,5		

It is determined the maximum arrow (S) and the length of the curved portion (L).

It is determined as:
- percentage ratio between the maximum arrow S (cm) and the length of the curved portion L (cm), or
- ratio between the maximum arrow S (cm) and the length of the curved portion L (m)

$$C_u = \frac{S}{L} \cdot 100, [\%] \qquad\qquad C_u = \frac{S}{L}, \frac{cm}{m}$$

In the case of the multiple curvatures, the quantification of this defect will be given by the ratio between the longer arrow and the length corresponding to the respective curvature.

According to SR 1294:1993 for the round resinous wood for industrialization there are admitted the curvatures:

Name of defect	Quality class		
	Resonance	*Aesthetic and technical veneer*	*Timber*
Simple curvature, %, max.	Not admitted	2	6
Multiple curvature, %, max.	Not admitted	Not admitted	Max. 2, in a plan

According to SR 2024:1993 for the round beech for industrialization, there are admitted the curvatures:

Name of defect	Quality class		
	Aesthetic veneer	*Technical veneer*	*Timber*
Simple curvature, %, max.	2	2	5
Multiple curvature, %, max.	Not admitted	Not admitted	Admitted in 2 plans with a max. size of 1

According to SR 1039:1993 for the round wood of the evergreen oak, oak, Hungarian oak and Turkey oak for industrialization, there are admitted the curvatures:

Name of defect	Quality class	
	Aesthetic veneer	*Timber*
Simple curvature, %, max.	2	6
Multiple curvature, %, max.	Not admitted	Admitted in 2 plans with a max. size of 3, in each plan

According to SR 3302:1993 for the round wood of different "hard" and "soft" essences for industrialization, there are admitted the curvatures:

Name of defect	Quality class	
	Aesthetic and technical veneer	*Timber*
Simple curvature, %, max.	2	6
Multiple curvature, %, max.	Not admitted	Admitted in the same plan with a max. size of 2

MATERIALS AND METHODS

The problem is as it follows: how much it is necessary to be cut from a piece (log), which presents a curvature, which exceeds the maximum admitted limit, so that the new piece which results be within the admitted tolerances.

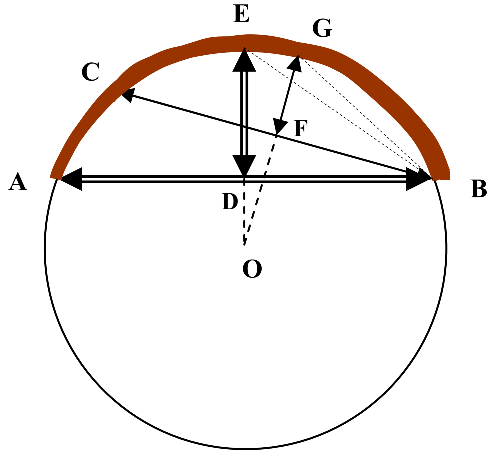

Fig. 2 - Curvature associated to a circle arch

There are known: AB = L - the length of the log (measured as the segment which links the two sides)

DE = S - the arrow

$$\frac{FG}{BC} = C_{adm} - \text{the admitted curvature}$$

Condition: the curvature of the log $\left(\frac{DE}{AB}\right)$ be bigger than C_{adm}.

It is requested: to be determined the length of the part that needs to be cut from the log (AC), so that the remaining part range within the limits of tolerances ($Cu \leq C_{adm}$)

Solution:

If the radius of the circle is noted with R, it is obtained:

$$R = \frac{4S^2 + L^2}{8S}$$

The length of the piece, which will be obtained after sectioning and that will have a curvature equal to that admitted, is:

$$l = BC = \frac{C_{adm}\left(4S^2 + L^2\right)}{S\left(1 + 4C_{adm}{}^2\right)}$$

$$\left.\begin{aligned} \overline{AB} &= \frac{\pi R}{90}\arcsin\left(\frac{L}{2R}\right) \\ \overline{BC} &= \frac{\pi R}{90}\arcsin\left(\frac{l}{2R}\right) \\ \overline{AC} &= \overline{AB} - \overline{BC} \end{aligned}\right| \Rightarrow \overline{AC} = \frac{\pi R}{90}\left[\arcsin\frac{L}{2R} - \arcsin\frac{l}{2R}\right]$$

The part of the log which has to be sectioned in order to leave a piece that can range within the tolerances will be given by the relation:

$$AC = 2R \cdot \sin\left(\frac{\overline{AC} \cdot 90}{\pi \cdot R}\right)$$

RESULTS AND DISCUSSION

The formula can be applied to obtain the values of the parts which need to be cut in the case of the diverse types of raw wood.

For example, it can be calculated how much it is needed to be cut from a resinous log which presents a curvature beyond that admitted, in order to correspond to the conditions of admissibility of class C - round wood for timber.

According to SR 1294:1993 (round resinous wood for industrialization) the logs from class C - timber - must have:

- the minimum diameter at the thin side: 18 cm
- the length (cm): from 2.5 to 3.0 from 0.25 to 0.25 and over 3.0 from 0.5 to 0.5.

For this range, according to SR 1294:1993, the simple maximum admitted curving is of 6%.

By applying the above formula for different L lengths of the logs, depending on the S arrow there can be drawn a table with the minimal values of the lengths of the portions which need to be sectioned, in order to obtain a shorter log which respects the maximum admitted curvature (C_{adm}=6%).(Table 2). The notations are the same as in the previous chapter.

Table 2

The determination of the length of the portion that needs to be sectioned (AC) for a resinous log from class C, of length L (for which we know the arrow and the length) in order to decrease its curvature to 6%

S (m)	**Cu , %**	**Observations**	**R , m**	**l, m**	**AC, m**
L = 2,50 m					
0,01-0,15	≤ 6,0%	The log doesn't have to be sectioned	-	-	-
≥0,16	>6,0%	The log will be sorted in an inferior range*	-	-	-
L = 2,75 m					
0,01-0,16	< 6,0%	The log doesn't have to be sectioned			
0,17	6,2	it is cut	5,65	2,67	0,08
0,18	6,5	it is cut	5,34	2,53	0,23
≥0,19	>6,8%	The log will be sorted in an inferior range*	-	-	-
L = 3,00 m					
0,01-0,18	≤ 6,0%	The log doesn't have to be sectioned	-	-	-
0,19	6,3	it is cut	6,02	2,85	0,16
0,20	6,7	it is cut	5,73	2,71	0,30
0,21	7,0	it is cut	5,46	2,58	0,43
≥0,22	>7,2%	The log will be sorted in an inferior range*	-	-	-
L = 3,50 m					
0,01-0,21	≤ 6,0%	The log doesn't have to be sectioned	-	-	-
0,22	6,3	it is cut	7,07	3,35	0,16
0,23	6,6	it is cut	6,77	3,20	0,30
0,24	6,9	it is cut	6,50	3,08	0,44
0,25	7,1	it is cut	6,25	2,96	0,56
0,26	7,4	it is cut	6,02	2,85	0,68
0,27	7,7	it is cut	5,81	2,75	0,78
0,28	8,0	it is cut	5,61	2,65	0,88
0,29	8,3	it is cut	5,43	2,57	0,97
≥0,30	>8,5	The log will be sorted in an inferior range*	-	-	-
L = 4,00 m					
0,01-0,24	≤ 6,0%	The log doesn't have to be sectioned	-	-	-
0,25	6,3	it is cut	8,13	3,84	0,16
0,26	6,5	it is cut	7,82	3,70	0,31
0,27	6,8	it is cut	7,54	3,57	0,45
0,28	7,0	it is cut	7,28	3,45	0,57
0,29	7,3	it is cut	7,04	3,33	0,69
0,30	7,5	it is cut	6,82	3,23	0,80
0,31	7,8	it is cut	6,61	3,13	0,91
0,32	8,0	it is cut	6,41	3,03	1,01
0,33	8,3	it is cut	6,23	2,95	1,10
0,34	8,5	it is cut	6,05	2,86	1,19
0,35	8,8	it is cut	5,89	2,79	1,27
0,36	9,0	it is cut	5,74	2,71	1,35
0,37	9,3	it is cut	5,59	2,65	1,42
0,38	9,5	it is cut	5,45	2,58	1,49
≥0,39	>9,7	The log will be sorted in an inferior range*	-	-	-

*it is recommended that the log be sorted in an inferior range because through sectioning (in order to obtain a piece with the admitted curvature), it would result a too short piece.

In figure 3, there has been represented the variation of the portion that needs to be cut from a resinous log with a bigger curvature than the admitted one for class C (6%), for different lengths.

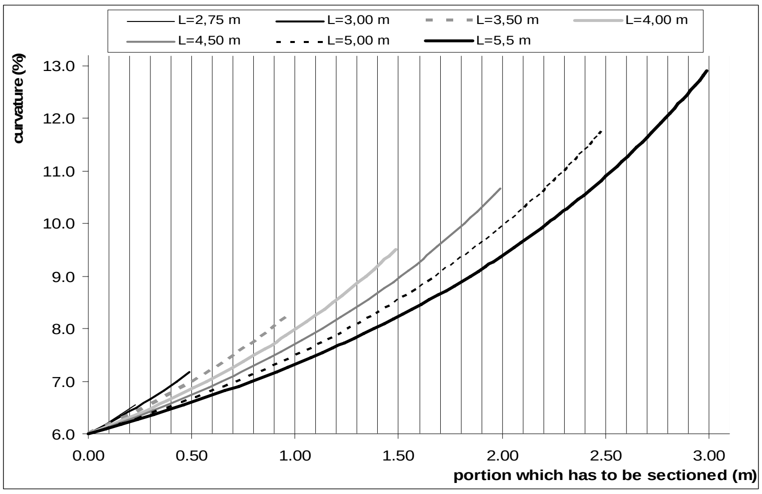

Fig. 3 The variation of the portion that needs to be cut from a resinous log with a bigger curvature than the admitted one for class C (6%), for different lengths

For curvatures superior to those represented (for each category of length), the log will be sorted into an inferior range.

There can be proceeded in the same way for the beech:

According to SR 1294:1993 (Round beech wood for industrialization), the logs from class C - timber - have to have:

- a minimum diameter at the thin side of 18 cm
- length (cm): from 2.4 m with stairs to every 10 cm.

For this range, according to SR 2024:1993, the simple maximum admitted curvature is of 5%.

Table 3

The determination of the length of the portion which needs to be sectioned (AC) for a beech class C log, of a L length (for which we know the arrow and the length) in order to decrease the curvature to 5%

S (m)	Cu , %	Observations	R , m	l, m	AC, m
L = 2,40 m					
0,01-0,12	≤ 5,0%	The log doesn't have to be sectioned	-	-	-
≥0,13	>5,0%	The log will be sorted in an inferior range	-	-	-
L = 2,50 m					
0,01-0,12	< 5,0%	The log doesn't have to be sectioned			
0,13	5,2	it is cut	6,07	2,41	0,10
≥0,14	>5,5%	The log will be sorted in an inferior range	-	-	-
L = 2,60 m					
0,01-0,13	≤ 5,0%	The log doesn't have to be sectioned	-	-	-
0,14	5,4	it is cut	6,11	2,42	0,19
≥0,15	>5,7%	The log will be sorted in an inferior range	-	-	-
L = 2,70 m					
0,01-0,13	≤ 5,0%	The log doesn't have to be sectioned	-	-	-
0,14	5,2	it is cut	6,58	2,61	0,10
0,15	5,6	it is cut	6,15	2,44	0,27
≥0,16	>5,8	The log will be sorted in an inferior range	-	-	-
L = 2,80 m					
0,01-0,14	≤ 5,0%	The log doesn't have to be sectioned	-	-	-
0,15	5,4	it is cut	6,61	2,62	0,19
0,16	5,7	it is cut	6,21	2,46	0,35
≥0,17	>6,0	The log will be sorted in an inferior range	-	-	-
L = 2,90 m					
0,01-0,14	≤ 5,0%	The log doesn't have to be sectioned	-	-	-
0,15	5,2	it is cut	7,08	2,81	0,10
0,16	5,5	it is cut	6,65	2,63	0,27
0,17	5,9	it is cut	6,27	2,48	0,43
≥0,18	>6,1	The log will be sorted in an inferior range	-	-	-
L = 3,00 m					
0,01-0,15	≤ 5,0%	The log doesn't have to be sectioned	-	-	-
0,16	5,3	it is cut	7,11	2,82	0,19
0,17	5,7	it is cut	6,70	2,65	0,35
0,18	6,0	it is cut	6,34	2,51	0,50
≥0,19	>6,2	The log will be sorted in an inferior range	-	-	-
L = 3,50 m					
0,01-0,17	≤ 5,0%	The log doesn't have to be sectioned	-	-	-
0,18	5,1	it is cut	8,60	3,40	0,10
0,19	5,4	it is cut	8,15	3,23	0,28
0,20	5,7	it is cut	7,76	3,07	0,44
0,21	6,0	it is cut	7,40	2,93	0,58
0,22	6,3	it is cut	7,07	2,80	0,72
0,23	6,6	it is cut	6,77	2,68	0,84
0,24	6,9	it is cut	6,50	2,57	0,95
0,25	7,1	it is cut	6,25	2,48	1,06
≥0,26	>7,3	The log will be sorted in an inferior range	-	-	-
L = 4,00 m					
0,01-0,20	≤ 5,0%	The log doesn't have to be sectioned	-	-	-
0,21	5,3	it is cut	9,63	3,81	0,19
0,22	5,5	it is cut	9,20	3,64	0,36
0,23	5,8	it is cut	8,81	3,49	0,52
0,24	6,0	it is cut	8,45	3,35	0,67
0,25	6,3	it is cut	8,13	3,22	0,80
0,26	6,5	it is cut	7,82	3,10	0,93
0,27	6,8	it is cut	7,54	2,99	1,04
0,28	7,0	it is cut	7,28	2,88	1,15
0,29	7,3	it is cut	7,04	2,79	1,25
0,30	7,5	it is cut	6,82	2,70	1,34
0,31	7,8	it is cut	6,61	2,62	1,43
0,32	8,0	it is cut	6,41	2,54	1,51
0,33	8,3	it is cut	6,23	2,47	1,59
≥0,34	>8,4	The log will be sorted in an inferior range	-	-	-

For logs with lengths bigger than the double of the minimum length of the respective range ($L \geq 5.0$ m for resinous, $L \geq 4.8$ m for beech) and very curved, from the portions sectioned at the thin side, in order to obtain a piece with an admitted curvature, there can be achieved subsequently (through sectioning) optimum ranges by repeating the procedure (for example, when the cut parts exceed 2.5 m for resinous or 2.4 m for beech).

CONLUSIONS

The curvature is a serious and quite a frequent defect (Table 1) that diminishes the value of the logs.

In the given examples (Tables 2 and 3), there can be noticed that the part which needs to be sectioned, so that the log correspond to the demands can be quite big (20-30% of the length) when the curvature goes beyond 3-5% of the admitted value.

For example, for the round resinous wood for industrialization, class C, for a log length of 4.00m:

- for a shorter arrow of 24 cm the piece doesn't have to be sectioned.
- when $S = 35$ cm there will be removed 1.27 m (recommended at the thin side)
- when $S \geq 39$ cm, the log will be sorted in an inferior range, because, otherwise, through sectioning (in order to obtain a piece with an admitted curvature), it would result a too short piece (<2.50 m length).

For beech, class C, the admitted curvature is of only 5% so that the parts which need to be sectioned in order to respect the demands must be bigger; for example, at a length of 4,00m, when the arrow is of 33 cm, the length of the portion which has to be sectioned will be of 1.59 m.

The sectioning will be done at the side where it contains many defects, recommendable at the thin side, and the shorter resulted piece after sectioning (AC) will be included within at an inferior range.

Generally, the curvature of the class C logs reduces the quantitative efficiency in timber (with about 10% for a curvature of 1%), and from a quantitative point of view the resulted timber will have inclined fibres.

The analysed problem gives practical solutions for the sorters and woodworkers in order to diminish this serious defect through sectioning in a well determined place.

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