PRECISION AND OPPORTUNITY TO USE THE TOTAL AREA OF CROSS-SECTIONS OF CLIPINGS AND KERFS AS A SECOND CRITERION FOR RE-ARRANGEMENT OF SAWING PATTERNS FOR ACHIEVING MAXIMUM YIELD

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Abstract

Our numerous studies confirmed the concept of G. S. Iliev on determination of optimal thickness of lumber. However, the concept in its original variant allows small deviations in yield, which caused its limited application - only in the case of sawing patterns used at initial (base) stage and after that the concept is adapted, deviations are removed and the final values are identical with those obtained by the method of Titkov-Guttermann. The minimal deviation from the maximum possible quantitative yield designed by means of this concept allows to detect the factor effect and to determine the total area of cross-sections of clippings and kerfs. The total area is used as a second criterion in re-arrangement of the basic sawing pattern by changing the lumber thickness without decrease in yield. The paper compares two approaches for determining the basic sawing patterns: 1) the unified concept of G. S. Iliev and 2) the hypothesis of G. S. Iliev with the scheme of Titkov-Guttermann. The results showed that after re-arrangement of basic sawing patterns they reach the maximum values of yield in both cases. The way of application and the necessary precision in the adjusting of areas are proposed.

Key words: *sawing patterns, live sawn, fixed cant sawn, individual log sawing, batch log sawing*

INTRODUCTION

The proposed method for modeling of log sawing by designing of sawing patterns aimed at maximal yield (Blagoev, 2004) is based on two facts. The first one is the sufficient precision of the unified concept of G. S. Iliev (1961) in determining of lumber thickness at basic sawing patterns used at initial stage. The second one is the possibility for re-arrangement of basic sawing patterns by replacing the board thicknesses by standard values, or by values required according to a specification and further achieving maximum yield by means of newly set values of thicknesses.

A minimal deviation of the values in the case of the basic sawing patterns is previewed in the concept of G.S. Iliev because the optimal thick ness here is a result of adjusting the areas of cross-section of clipping to the right-situated craft. This concept is characterized by using of an asymmetric scheme as a result of considering of right-situated craft, which differs from some points in the theory of the maximum sawing patterns (Aksenov, 1960) for determining of the optimal lumber thickness depending on their situation in the cross-section of log. In this respect, the theory of Titkov-Guttermann for determining the optimal board thickness through including of adjacent half-kerfs from both sides is in accordance with the theory.

The method is new; it is widened in its contents and way of application and requires additonal information regarding both the precision in determining the widths and yield in basic sawing patterns and the approach of application of method, which was the aim of the present study.

METHOD OF STUDY

Achieving the objective set is based on comparison of two methods of determining the optimum thicknesses of lumber at maximum sawing patterns, using the concept of G. S. Iliev. The first one is application of the above-mentioned unified concept: the lumber has optimal thickness in the case of adjusting the area of cross-section of clipping with the one of the right situated kerf, when considering one-fourth of the circle. This method has been described and published elsewhere (Blagoev, 2004) and the width of the boards were included in the algorithm. The example concerns large-diameter logs: d_{sed} = 60 cm; L = 5 m; S = 0.5 cm/m; p = 3.2 mm and yielding larger number of boards, respectively, with taking into account the maximum error.

The example noted is used for additional designing of a basic sawing pattern using the second of the described above methods, consisting of application the concept of G. S. Iliev but using the scheme of the method Titkov-Guttermann, and with setting the maximum allowed deviation in the quantitative yield at the base (optimal) sawing patterns.

Except with the way of realization, the method is original also with the determining and using as a second criterion (Blagoev, 2004) the areas of cross sections clippings – F_{cl} and krefs – F_{kr}.

RESULTS

The main results of the study are presented on table 1. They concern the modelling of first-stage sawing, consisting of designing of sawing patterns using board thickness at adjusted areas of cross-sections of clippings and krefs. Table 2 represents modelling of second-stage sawing consisting of re-arrangement of the basic sawing pattern. The results allow the following brief inferences:

1. The analysis of characters at base sawing patterns without shortened lumber revealed that the results of the variants 1, 2 and 3 showed rather weak decrease of yield with decreasing of the precision in areas adjustment – between the variant 2 and 3 the difference is 0.185 %, while between 1 and 2 it is 0.045 %. This indicates that the yield depends directly on the precision set and that the level of inaccuracy accepted is sufficient because of reaching of a local maximum. At a precision set 0.1-0.5 cm^2 for adjustment of the areas, an extreme value of the yield is achieved – the difference between the variants 4 and 1 is 0.135 %. This fact points out the possibility for achieving the partial case of optimum at the basic sawing patterns.

2. The application of method of adjustment of areas with a precision of 0.01 to 0.5 cm^2 allows determining the optimal values of board thickness in the inner log zone and respective drawing of this zone. In the outer zone the board thickness should be determined also by adjustment of areas. In order to decrease the variation in the case of shortened lumber, I accepted higher and equal value of the thickness in all variants and here the adjustment of areas is limited. In spite of this, the results are logically connected to the precision set.

3. Designing of basic sawing patterns by using the unified concept of G.S. Iliev is related to achieving of lower yield – 1.8 % in the example noted (maximum deviation), which is a result of use the whole kerf width of one side of the board considered.

4. Re-arrangement of the basic sawing pattern (variant 1 in Table 1) is done by including of thickness values required by standard or by specification. The choice of these values consider the rules noted above for achieving higher yield. These conditions are added also by the attempt to obtain higher number of boards with equal thickness, as well as with larger thickness. When these requirements are met, the results in Table 2 show that the best variant is 1.4. There the yield is the highest – R_j = 83.868 %, and the total cross-section area of the clippings is the highest, and the total one between the clippings and kerfs is the lowest.

5. The values of quantitative yield obtained at the base and re-arranged sawing patterns following the unified concept of G.S. Iliev, are 82.63 and 83.73 %, respectively. The application of the second method for determining the thickness – combining the concept of Iliev with the method of Titkov-Guttermann – showed that in the case of re-arranged sawing patterns the same quantitative yield is achieved – 83.725 %. The results concerning the yield at sawing patterns presented in Table 2 are identical. They were processed by using the above-mentioned two approaches. Therefore, the final variants after re-arrangement of the awing patterns exclude all the differences in the yield between the two approaches of designing sawing patterns.

CONCLUSIONS

An original method was proposed for modeling log-sawing that is realized into two stages. During the first stage a basic sawing patterns are designed and the areas of cross-sections of clippings and kerfs are determined. During the second stage the basic sawing patterns are re-arranged by replacing the board thickness by required, or desired values without or with minimum deviation from the maximum yield and the value of this deviation is known.

REFERENCES

Aksenov P., 1960. Theoretical basis of the raw-materials sawing. Moscow-Lenningrad, Goslesbumizdat (in Russian).

Iliev G.S., 1961. Determining the maximum yield of lumber. Moscow-Lenningrad, Goslesbumizdat (in Russian).

Blagoev G., 2004. Modeling of the process of sawing logs to lumber. Thesis for Dr. Sc. Degree, Sofia (in Bulgarian).

Table 1. Simulation modeling of the first stage sawing. Characteristics of the basic sawing pattern at set preciseness A, cm ^{2}

Variant No preciseness A, cm^2	Abbreviated sawing patterns including boards with consecutive numbers from the center to the periphery of the log							Evaluation characteristics Rj, %; ΣFcl, cm^2; ΣFkr, cm^2	
	1	2	3	4	5	6	7	Without shortened lumber	Total for the sawing pattern
Variant 1; A=0.01 c m^2								Rj = 83.932 %	Rj = 84.429 %
Thickness, mm	92.65	58.12	43.47	33.09	24.39	16.38	10.50*	ΣFcl = 40.6311	ΣFcl = 41.8625
Width, mm	569.62	513.02	443.17	363.89	276.98	183.04	116.36	ΣFkr = 40.6255	ΣFkr = 42.8225
Length, mm							3.00	Σ = 81.2566	Σ = 84.6850
Fcl, cm^2	9.3505	8.6470	7.6159	6.4035	5.0512	3.5629	1.2314		
Fkr, cm^2	9.3527	8.6404	7.6142	6.4040	5.0509	3.5633	2.1970		
Variant 2; A=0.1 cm^2								Rj = 83.887 %	Rj = 84.419 %
Thickness, mm	92.30	57.90	43.30	33.00	24.30	16.50	10.50*	ΣFcl = 40.0882	ΣFcl = 41.2530
Width, mm	569.85	513.71	444.51	366.05	280.49	187.96	124.31	ΣFkr = 40.7960	ΣFkr = 43.1055
Length, mm							3.00	Σ = 80.8842	Σ = 84.3585
Fcl, cm^2	9.2437	8.5419	7.5109	6.3156	4.9468	3.5294	1.1648		
Fkr, cm^2	9.3545	8.6479	7.6307	6.4325	5.0972	3.6333	2.3095		
Variant 3; A=0.5 cm^2								Rj = 83.702 %	Rj = 84.424 %
Thickness, mm	91.00	57.00	42.80	32.80	24.30	16.60	10.50*	ΣFcl = 38.2774	ΣFcl = 39.9077
Width, mm	570.70	516.34	449.35	373.46	291.20	204.15	126.23	ΣFkr = 41.3611	ΣFkr = 43.8325
Length, mm							4.00	Σ = 79.6385	Σ = 83.7402
Fcl, cm^2	8.8540	8.1317	7.1761	6.0595	4.7420	3.3140	1.6303		
Fkr, cm^2	9.3614	8.6761	7.6911	6.5319	5.2449	3.8558	2.4714		
Variant 4; A=0.5 cm^2								Rj = 84.067 %	Rj = 84.395 %
Thickness, mm	94.30	59.10	44.10	33.40	24.45	15.95	10.50*	ΣFcl = 42.9578	ΣFcl = 43.8882
Width, mm	568.52	509.80	437.13	354.33	262.56	161.70	102.09	ΣFkr = 39.8863	ΣFkr = 41.7644
Length, mm							2.25	Σ = 82.8441	Σ = 85.6526
Fcl, cm^2	9.8659	9.1351	8.0537	6.7695	5.3741	3.7596	0.9304		
Fkr, cm^2	9.3438	8.6053	7.5391	6.2774	4.8551	3.2655	1.8781		

Table 2. Simulation modeling of sawing at second stage. Development of the basic sawing pattern by replacing the l umber thickness by standard dimensions including measures for drying up

Variant No	Sawing patterns (thickness, mm)/(width, mm)/(length, m)								Area of cross-sections of clippings F_{cl} and kerfs F_{kr}. In the brackets without shortened lumber; * with shortened lumber	Yield R_j, %
1.1	47.0 / 592.07	47.0 / 566.53	47.0 / 520.76	42.0 / 457.32	31.5 / 387.84	21.0 / 322.12	21.0 / 228.95	21.0* / 120.90 / 2.0	ΣFcl = (29.6587), 34.8344* ΣFkr = (51.9031), 54.5366* Σ = 81.5618, 89.3710*	83.451
1.2	52.5 / 590.16	47.0 / 562.57	47.0 / 514.31	42.0 / 447.75	31.5 / 374.47	21.0 / 304.14	21.0 / 200.24	21.0* / 102.52 / 0.50	ΣFcl = (32.1225), 36.4781* ΣFkr = (50.7996), 53.0224* Σ = 82.9221, 89.5005*	83.494
1.3	52.5 / 590.16	52.5 / 558.37	42.0 / 513.71	42.0 / 446.86	26.0 / 386.66	26.0 / 304.14	21.0 / 200.24	21.0* / 102.52 / 0.50	ΣFcl = (31.9331), 36.2866* ΣFkr = (50.9054), 53.1281* Σ = 82.8365, 89.4147*	83.505
1.4	52.5 / 590.16	52.5 / 558.37	52.5 / 500.44	42.0 / 427.11	31.5 / 345.13	21.0 / 263.18	21.0 / 121.35	10.5* / 96.34 / 0.50	ΣFcl = (39.6094), 39.3027* ΣFkr = (48.3576), 49.7924* Σ = 87.9670, 89.0951*	83.868
1.5	52.5 / 590.16	52.5 / 558.37	52.5 / 500.44	42.0 / 427.11	42.0 / 313.15	21.0 / 214.89	21.0* / 130.81 / 0.50		ΣFcl = (38.8079), 42.4554* ΣFkr = (44.5121), 47.1100* Σ = 83.3200, 89.5654*	83.116