MATHEMATICAL MODELING CUTTING ROUND TIMBER ON LUMBER

T. Koval, Candidate Physical and Mathematical Sciences

The mathematical model for calculating the volume output of lumber. Past studies on the production of the actual output when cutting timber edging material. A system of programs for calculations posture, optimum-cutting plans, allowing them to carry out feasibility study.

Mathematical model timber, the volume output, techno - economic evaluation, the calculation was.

At present in the finished product, wood is used only 20-30% of the raw materials, so the challenge is rational and integrated use lumber, which is great and most valuable part of round timber. An important factor in the rational use of wood is to increase the volume, and varietal timber specification of outputs that can be achieved by improving the efficiency of the sawmill production, technical re-equipment of enterprises saw at the art equipment and technology with the use of computer technology.

Aim research Development of a mathematical model for calculating the put, which gives the opportunity to optimize raw material consumption for the production of sawn timber.

Materials and Methods research Costs of raw materials when cutting depends on the adopted technology, technology and cutting-sheet materials and lumber. With technology, one of the main factors is the choice of the optimal posture for cutting each dimensionally - quality saw logs group that can perform data timber with a minimum amount of material. Block diagram of cutting programs raw materials is shown in Fig. 1.

Structural diagram of the program for the calculation of posture and optimal plans for cutting materials including: power input information on the number and size-quality raw data, specification timber. The next block is determined by the volume output timber. Put a calculation model was developed based on the theory of basic raw material for cutting boards. [2] It provides a sequence of logical and

mathematical operations performed by a technologist in the preparation and calculation of posture. After assembly is made possible posture evaluation for

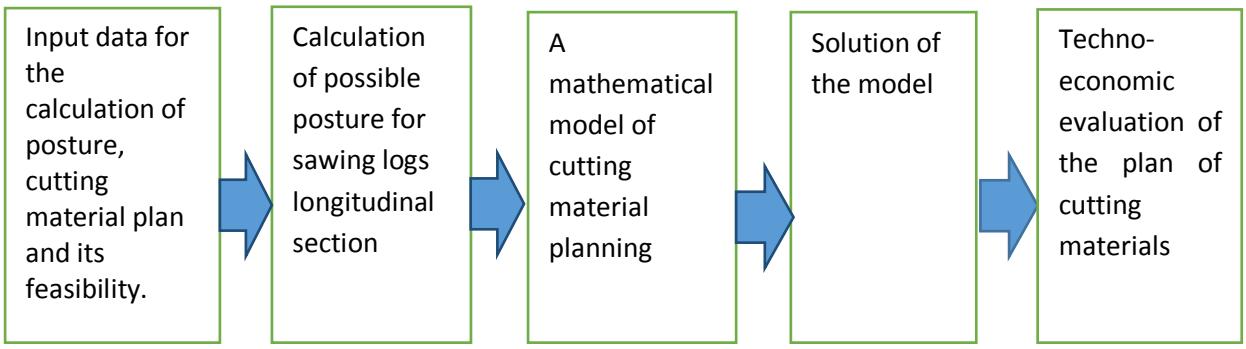

Fig. 1. Structural diagram optimization program for cutting raw lumber

volume output of lumber and shown a certain amount of appropriate posture for inclusion in the planning mathematical model of cutting material.

The research results As a result, generalization and mathematical processing of experimental data obtained model.

General view of the mathematical model of material cutting plan is as follows:

$$\sum_{k=1}^{n}\sum_{t=1}^{l_k} V_{itk} n_{ik} \geq V_i^{\min} \qquad (i = 1, 2... m)$$

$$\sum_{k=1}^{n}\sum_{t=1}^{l_k} V_{itk} n_{ik} \leq V_i^{\max} \qquad (i = 1, 2,..., m_{1)})$$

$$\sum_{i=1}^{m}\sum_{k=1}^{n}\sum_{t=1}^{l_k} V_{itk} n_{ik} \geq V$$

The objective function implements the standard minimum cost for a given volume of raw lumber and raw materials:

$$F(x) = \sum_{k=1}^{n}\sum_{t=1}^{l_k} Q_k n_{ik} = \min$$

Notation for the model:n - total number of size groups of logs;l_k - the total number of possible posture for cutting logs k-th size group;V_{itk} -volume timber i-th section, the expected opening in the t-th posture log k-th size group;n_{ik} -the number of log k-th size group, cut out the t-th posture;$V_i^{\min}, V_i^{\max}, V$ - In accordance with the minimum allowable, the maximum amount of timber i-th section, the total amount of all outstanding timber sections;m - total number of sections of lumber;Q_k- the

total amount of raw material all size groups;*F (x)* - the objective function, which is the optimality criterion spray plan - minimum cost of raw materials.

Choosing the optimal posture for cutting logs parties carried out by linear programming, this will lead to being able to choose the appropriate way of sawing and, if necessary, adjust the cutting plan.

In the first phase of the plan to solve the problem of cutting material preparation and calculation of posture for the production of timber edging.

The task of cutting round timber to timber specification resolved among mathematical processor MathCAD. [3]. Application of MathCAD effectively in solving problems which need solution of systems of equations. From a mathematical point of view, the problem is simple, but a significant amount of calculation converts the problem, as in this case, including more than 10 equations in technically complex, due to the almost inevitable errors. [4].

According to the algorithm of the program in the first, stage the introduction of the basic characteristics of materials.

The main characteristics of the raw materials, the calculation in this program include wood, length and thickness of the deck, as well as grade timber. The main parameters of the log program calculates automatically based on typed dependencies and data entered into the database program (tapering logs relevant species, the minimum size of the boards, and the allowance for shrinkage).

To determine bottom end diameter logs, log volume, value maximum coverage logs posture, the critical area of the deck in the program introduced known dependence [5].

The task of calculating the position and the apparent withdrawal of lumber is solved in two stages. In the first stage, the size of timber and surround them out in a cylindrical area of the deck. The second - in the parabolic zone, which takes into account the shorter length compared with timber logs.

The procedure for calculating the size of the next timber edging - input boards with thicknesses consistent location relative to the center of the deck boards to determine the number of posture, putting kerf thickness.

Calculation of edging and timber surround their release is made introduction to the program known equations to determine the width and length lumber [6].
The program automatically carries out rounding of width and length of boards to default.

Calculation of bearing for cutting materials with a diameter of 36 cm, length 6 m on board lumber thickness of 50 mm and its comparison with actual data obtained in a production environment, showed that by using a cylindrical zone decks surround output for a given specification thickness of lumber is 79%, the actual measurements of the boards by -77.2%.

Pay attention to the fact that in the calculation of real deliver analytical or graphical method using nomograms and graphs deliver maximum may only determine the maximum volume relative yield of timber, without regard to their quality and the possibility of the given specifications. Because sorting of logs provided by a pair and a group of diameters between the diameter of logs varies continuously surround output even within timber diameters may differ from the calculated. Given this, the calculations were made in accordance with the theory put maximum should be considered as a maximum output, which is a criterion in the comparative analysis put developed for real production conditions.

To check the calculation programs were put out experimental studies to determine the volumetric output of lumber at sawing logs into lumber edging. Investigations were carried out in a production environment. At the sawmill frame P-63 sawn timber thickness from 26 to 50 mm, 4.5 m long, tapering to a different timber 50 mm thick. Because in the specification laid lumber length 4.5 m in the preparation is only used to put the cylindrical area of the log.

The actual amount of the boards was determined by direct measurement of the size and scope of the analytical calculation. Along with this, the experimental data were processed using the program created in the environment of mathematical processor MathCAD.

The results are shown in Table 2

Found a model for calculating the actual and the estimated volume of lumber output

$$P_{fi} = 67,754 + 0,141x_i$$

$$P_{ri} = 69,734 + 0,166x_i$$

After the experiment and get, the full sample, the statistical data processing, homogeneity of variances tested by Fisher. It was found that the dispersion of uniform. Checking the average values of the t-test for samples with heterogeneous variances showed that between the averages of the two samples was no statistically significant difference.

Table 2. Comparison of actual and estimated volume of lumber output when cutting logs in a production environment

Consecutive number experience	Dimensions timbers				The volume of lumber,, m^3		Volumetric yield of timber,%	
	d, cm	D, cm	L, m	V, m^3	factual	calculated	factual	calculated
1	30	36	4,5	0,388	0,30	0,31	78,0	80,0
2	34	44	4,5	0,546	0,35	0,38	64,3	70,8
3	34	36	4,5	0,578	0,46	0,48	79,0	84,2
4	36	48	4,5	0,636	0,47	0,49	73,9	77,3
5	36	40	4,5	0,512	0,36	0,37	70,0	72,5
6	36	40	4,5	0,512	0,36	0,37	70,7	72,5
7	36	48	4,5	0,636	0,47	0,49	73,9	77,3
8	36	50	4,5	0,671	0,48	0,51	72,0	75,8
9	42	50	4,5	0,754	0,62	0,61	81,7	80,3
10	46	64	4,5	1,098	0,80	0,86	73,0	78,7
11	50	62	4,5	1,121	0,83	0,86	74,0	76,4

Based on calculations put on the developed program analyzes yield edging 50 mm thick lumber from logs of different diameters and tapering. According to the obtained regression, equations plotted output volume of uncut lumber thickness and tapering timbers (Figure 2.3)

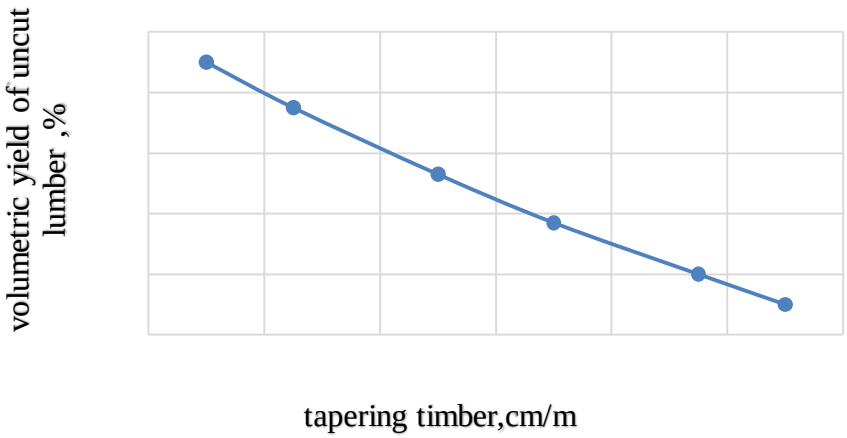

Fig.2. Dependence of the volume output of lumber from timber tapering

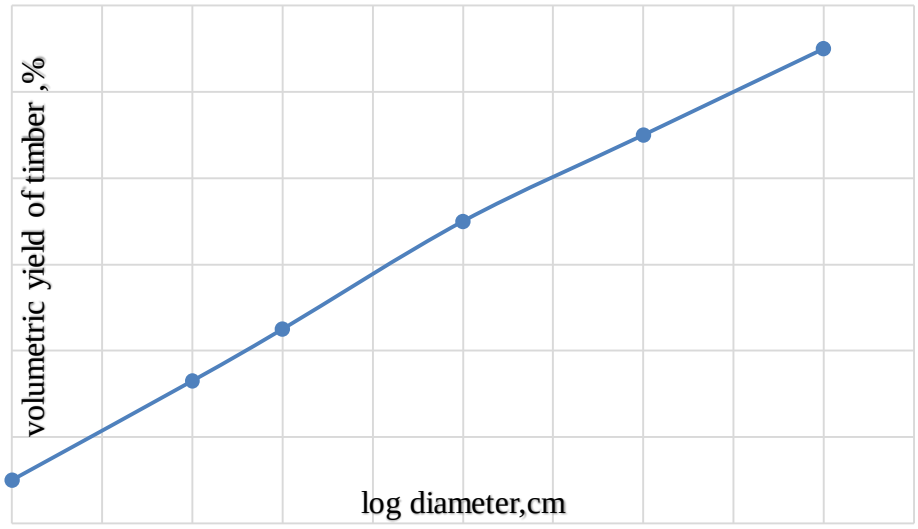

Fig 3. Dependence of the volume output of lumber from timber diameter

From these graphs, it can be concluded that by using only a cylindrical timber with a zone of increasing the volume of raw run out unhedged sawn yield decreases, resulting in an overrun of raw materials.

Conclusion

The software for the control of the process and calculate the volume output trimming and edging timber allows you to quickly determine the size of the boards by a given specification and surround output lumber of raw. Flow program to determine the cost of timber enables greater use of programs in the workplace.

Literature cited

1. Фельдман Х.Л. Система максимальных поставов / Х.Л. Фельдман// М.: 1932. 276 с.
2. Аксенов П.П. Технология пиломатериалов / Н.С.Макарова, И.К.Горохов ,. Ю.П Тюкина // М.: Лесн. пром-сть. 1976 .- 480 с.
3. Томашевский В. М. Моделирование систем./ В. М. Томашевский// - К.: BHV, 2005 .- 352 с.
4. Кирьянов Д Mathcad 13/ Д. Кирьянов// BXB-Петербург: 2006 .- 598с.
5. Рыкунин С.Н, Тюкина Ю.П, Шалаев В. С 2003: Технология лесопильно-деревообрабатывающих производств/ Ю.П. Тюкина, В. С. Шалаев // М: Изд-во МГУЛ, 2003. - 221 с.
6. Коваль В.С. Складання та розрахунок поставів для виробництва пиломатеріалів / Коваль В.С, Пінчевська. О.О// Київ: Аграр Медіа Груп, 2010. - 100 с.