

CUTTING OPTIMIZATION LUMBER ON BLANKS FOR PARQUET BOARDS

Stanislav Rykunin¹, Nadezhda Kulikova²
 Moscow State Forest University, Russia
¹rykunin@mgul.ac.ru, ²stelons@mail.ru

INTRODUCTION

The most common malformations of birch are knots, rot, and the curvature of the false nucleus.

False heartwood not allowed in the blanks always without any restrictions. This area has a low permeability of the wood, the tensile strength along the fiber toughness. In birch false core easily crack. False heartwood is resistant to rot less than the sapwood. Since the size of the false nucleus depends on the age of trees, it follows that the diameter between the diameter of sawlogs and heartwood correlation exists. Using data from the bulkhead material was determined by the dependence of the diameter of the heartwood of the diameter of sawlogs in the butt. Relationship is expressed by the equation:

$$d_{hw} = 0,032 + 0,417D_k \quad (1)$$

d_{hw} – The diameter of heartwood in the butt cut;

D_k – The diameter of the ridge in the butt cut.

The correlation coefficient $r = 0,603$; error correlation coefficient $mz = 0,048$. In the butt cut ridges only 18.5% have no heartwood.

Thus, these data can be guided to develop and organize a separate piece sapwood and heartwood, for example, using beam-cutting scheme. The current Russian standards are not fully exclude the lack of finished products for flooring presence of false heartwood and healthy knots conjoined on open surfaces, but the variety of products deteriorates. This sort of product could be developed into a separate category, where the presence

of sound knots and heartwood is aesthetically appealing in certain design styles.

More than half of birch logs has curvature.

The experimental results showed that with decreasing length of the assortment of „n“ time deflection also decreases by about a „n“ time, that is, the value of the curvature of the assortment, expressed in % change of its length remains virtually unchanged. In this case, increase the yield of blanks can individual approach to cutting of timber.

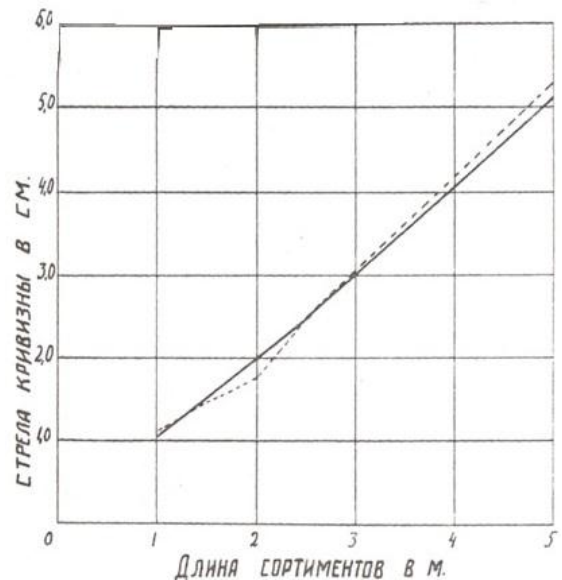


Fig. 1. The dependence of the radius of curvature of the length of the blanks

The task of optimizing the process of cutting timber on the workpiece in a general form is as follows.

The objective function

$$D = \sum_{j=1}^n d_j(z_1, z_2, \dots, z_h) x_j \longrightarrow \max \quad (2)$$

where D – net profit.

$$D = S_I - C - EK \quad (3)$$

where S_I – value-yield products derived from 1 m³ of sawn wood, rub.

C – cost of products obtained from 1 m³ of sawn wood, rub.

E – efficiency coefficient, year – 1 under the constraints

$$\sum a_{ij}x_j \geq b_i, i = 1, 2, 3, \dots, l;$$

$$\sum x_j \leq m_k, k = 1, 2, 3, \dots, L;$$

$$x_j > 0, j = 1, 2, 3, \dots, n;$$

d_j – net profit in the processing of 1 m³ of sawn timber on the j -th cutting pattern;

z_1 – the size of timber;

z_2 – quality timber;

z_3 – how cutting timber;

z_4 – kind of processing lumber;

z_5 – fragmentation of sorting lumber;

z_6 – the amount of bonded blanks;

n – number of schemes cutting timber;

x_j – the amount of lumber sawed at the j -th cutting pattern;

$a_{ij}x_j$ – blanks out the i -th group when cutting the j -th cutting pattern;

b_i – the volume of the i -th group of machines;

m_k – k -th volume of lumber;

L_k – cutting the number of schemes on the k -th group of lumber;

l – number of groups of machines;

t – number of groups of lumber.

To solve the problem it is necessary to get the value $a_{ij}x_j$.

These values are obtained by an analytical method with conducting experimental work.

ASSESSMENT OF QUALITY OF LUMBER INTENDED FOR CUTTING

The main cause of waste when cutting is the use of blanks for the production of lumber, is not relevant to them by quality of the wood. These wastes can be eliminated with the full line of quality lumber and slabs. However, the lumber will almost always have defects that are not allowed in the blanks and complete the mouth – hurt the quality of waste possible. You can achieve

the proper selection of waste reduction group timber for cutting to required sizes of slabs. Resolving this issue depends – screens and the system of quality assessment of wood in the blanks, saw-quality materials and in areas of logs.

DEFINING OUTPUT OF SAWN BLANKS

Using the techniques of regression analysis, we can obtain the regression equations yield the main piece, pieces of free length, their average length and number of pieces of free length, obtained from a non-conforming principal piece.

Experimental studies have confirmed that the length between slabs free length, and their occurrence in longitudinal cross-cutting way rated lumber back there, proportional relationship with high correlation coefficient.

Size distribution of free blanks length is defined as follows:

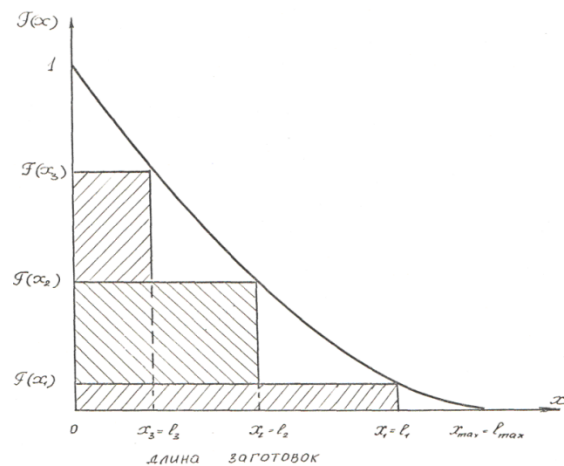


Fig. 2. Cumulative distribution curve of blank sizes free length

EXPERIMENT

Rational use of timber is largely dependent on compliance with quality lumber produced quality pieces. Lumber one section can be processed into shapes of various widths with different requirements according to the norms of allowable defects. In this

case, the purpose of rational use lumber timber may sorting them for quality.

It is known that the correlation ratio between the output slabs and lumber grade below 0.6. Therefore, sorting of sawn timber on the current Standard does not always produce the desired effect.

We have developed a method of sorting lumber were the main – rank out of the main slab.

Membership lumber, intended for in-plant processing, to a certain group of appropriate quality is determined from the main exit for logging and lumber quality criterion to factor out the blanks.

Let out of the board can be obtained by 6 major pieces. Because of the presence of

defects in the board may receive only 3 slabs. Then factor out the main piece is 0.5.

Definition of timber belonging to one group or another the quality is easier than determining the grade, as in determining the grades necessary to evaluate the effect of several wood defects and processing.

Sorting timber according to this criterion is not only simplifies the process, but also takes into account the current trend to change compared – magnitude of allowable defects in the blanks of various groups, including construction.

Based on the basic requirements, as well as a number of technical terms used in plants producing flooring from birch wood, the input assign the factors shown in table 2.

Table 2. Variable factors in the experiment

Name	Designation factors in the natural scale	Unit	Range
The total length of the defect and knot free zones on the board	ΣL	mm	5300 5600 5900
Permissible diameter of knots on the slabs	d	mm	10...30
Width slabs	b	mm	50...100
Length slabs	l	mm	500...1500

Parameter characterizing the quality of the timber - the total length of defect and knot free zones in the board.

Experimental research on cutting timber on the workpiece to provide information about the following output factors:

1) The coefficient of volume output core piece of the maximum possible output data pieces according to their number;

2) The coefficient of volume out of short pieces of the free length with knots;

3) The average length of short pieces;

Go to the measured defects include: knots face of a plank of all kinds - as the dominant factor in the quality of lumber,

wormholes than 3 mm; digging, snags, gashes, dents, chips, scratches, rot, stepson, bark, cancer and other significant defects.

Cutting timber in the blanks replaced with an imitation by means of a mathematical model, implemented on a computer program AutoCad.

The experiment was conducted using the B-plan of the second order. Number of trials-24, the number of duplicate experiments – 19.

Then the group boards the quality will be characterized by the following ranges of factors presented in Table 3:

Table 3. Identification of timber

Group number	n	Range, mm
1	ΣL_{min}	5200...5400
2	$\Sigma L_{cp.}$	5500...5700
3	ΣL_{max}	5800...6000

The purpose of the mathematical description of the characteristics of cutting timber on the workpiece is to obtain the regression equations for the output of the factors mentioned above.

RESULTS

The result of the experiment are derived equations that allow us to calculate:

- the coefficient of volume output main feed:

$$\hat{y} = 91.378 + 1.69 \cdot x_1 + 1.693 \cdot x_2 - 2.433 \cdot x_3 - 3.448 \cdot x_4 + 0.445 \cdot x_1^2 + 0.045 \cdot x_2^2 - 0.66 \cdot x_3^2 + 0.015 \cdot x_4^2 - 0.683 \cdot x_1 \cdot x_2 + 0.421 \cdot x_1 \cdot x_3 + 1.18 \cdot x_1 \cdot x_4 + 0.438 \cdot x_2 \cdot x_3 + 0.438 \cdot x_2 \cdot x_4 - 1.066 \cdot x_3 \cdot x_4 \quad (4)$$

- the coefficient of volume out of short pieces:

$$\hat{y} = 6.409 - 1.2 \cdot x_1 - 1.332 \cdot x_2 + 2.114 \cdot x_3 + 3.782 \cdot x_4 - 0.284 \cdot x_1^2 + 0.06 \cdot x_2^2 + 0.591 \cdot x_3^2 + 0.071 \cdot x_4^2 + 0.0448 \cdot x_1 \cdot x_2 + 0.454 \cdot x_1 \cdot x_3 - 0.159 \cdot x_1 \cdot x_4 - 0.35 \cdot x_2 \cdot x_3 - 0.814 \cdot x_2 \cdot x_4 + 0.071 \cdot x_3 \cdot x_4 \quad (5)$$

Accounting for heartwood and curvature, as well as the coefficient of volume output and the main piece of short pieces, allows efficient use of birch lumber and reduce the cost of production of workpieces.

REFERENCES

- Ugolev, BN Wood from forest-based merchandising - Moscow: State Educational Institution MSFU, 2005. – 340.
- GOST 2140–81. Visible defects of wood. Classification, terminology and definitions, methods of measurement.
- GOST 2695–83 Lumber hardwood. Specifications.
- GOST 862. –85 Parquet products. Parquet. Specifications.
- GOST 862.3–86 Parquet products. Hardwood boards. Specifications.
- GOST 8242–88 „details the profile of wood and wood materials for construction. Specifications“
- GOST 4.223–83 hardwood products. Nomenclature of indices.