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The Influence of Log Offset on Sawn Timber Volume Yield

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Accuracy of aligning and positioning of log and cant during sawing in relation to blades in the sawing machine depends on equipment was used, shape and dimensions of the log or cant and human factor (if it is manual). Theoretically optimal positioning presupposes maximization of the volume yield but considerable impact was observed on value yield as well. For straight logs main positioning faults are caused due to log parallel and angle dislocation known also as offset and skew. Positioning faults affects location, type and values of wood features and sawn timber qualities forcing thus sawmill-men in Lithuania pay more and more attention and investments. The influence of offset on different production aspects was tested in the real typical sawmill as well as using elaborated by us special sawmill model.

Keywords: log, cant, sawn timber, sawing pattern, offset, volume yield, timber quality, sawmill model.

1. INTRODUCTION

Traditional technological and economical sawn timber production efficiency indices – productivity, production quality, complex utilization of raw material, energy consumption and other remain actual at all production stages. Still, some of them are affected by rapid implementation of new technologies and equipment. Along with already common conceptions of volume, specification and qualitative sawn timber yield has started existing a conception of value yield which is very sensitive to market demands and changes. Profitability of today's sawmilling becomes problematic without automated production management systems and modern computer programs. Work based on experience and intuition only means a loss in the competition with new production planning and optimization methods.

Sawn timber volume yield depends not only on the dimensions and shape parameters of raw material (sawlogs), but also on various log positioning errors: deviation of log aligning towards the centre of saw pattern, no parallelism of its axis to the infeed direction, on the angle of rotation a sweep log around its longitudinal axis and other [1, 2]. The log dimensions (length, width, top end diameter and sweep) may be measured before the beginning of sawing, as well as the volume yield of sawn timber may be calculated. Meanwhile positioning errors depend on the centering device adjustment and on proper feeding of logs, so their effect can be determined only after sawing was completed.

In a sawmill an expected volume yield is usually calculated with the trust that a properly positioned log is sawn. Results of many investigations show that it has not been ascertained quite precisely and substantial deviations on the volume yield have been observed [3, 4]. The results of experiments therefore should be analyzed individually.

Primary log positioning and its further sawing determine lumber assortments and the overall yield. Errors of primary sawing cannot be corrected. So, it is necessary to control positioning errors. The presumption, that a log must be sawn without any errors by purchasing the expensive equipment which doesn't repay for a long time, is wrong. Besides, it cannot give the desired effect. The limit, up to which offset fails to cause more significant losses, must to be known.

Due to positioning errors the volume yield and especially value yield decrease, because significantly increase size of sawn boards wane. A. Labeda [5] states, that it is dangerous to overestimate the influence of positioning errors, because it is valid only under certain conditions. There not only the influence of different factors should be ascertained, but also their interrelation and influence on the final result should be revealed [6]. It is pointed, that during volume yield calculation, due to the discreteness of introduced standardized data, the influence of positioning error up to 3 – 5 mm is minor observable, while bigger positioning values follows a significant decrease in volume yield.

Practically it was proved, that using ultrasound-positioning equipment it is possible to increase sawn timber volume yield up to 6 %. The influence of offset is widely described in the works of Swedish scientists. Advanced sawmill industry is based in this country mainly on sequential scientific studies.

Without high-level log scanning and positioning equipment it is impossible to ascertain offset in the technological process [7 – 10]. However, J. Sederholm has worked out the methodic [11] for offset measuring.

Interesting are also the results of Russian scientists, which indicate that when moving a log in respect to the saw pattern axis, volume increment may be obtained only in certain diameter intervals [12]. However, real values presented by different scientists do not always coincide [13 – 15].

The influence of offset on sawn timber volume yield is still the object of discussions. At present, an increased interest of scientists from various countries in this problem is observed. They are seeking to evaluate and compare offset significance with other traditional factors affecting

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volume yield. It is necessary to know and evaluate not only the losses, but also economical efficiency of methods and means for their forecasting and correction.

In the production process it is very complicated to estimate the influence of offsets on volume yield, because a lot of technological and other factors have influence as well (log sweep, rotation of crooked log, kerf width, inclination error, board edging accuracy, etc.). A more precise and imitational ("virtual") sawing of logs abroad has specially designed and widely applied programmed equipment [3, 4, 16 – 19]. Using a special yield optimization program, the influence of offsets on sawn timber volume yield of logs of various diameters and lengths was evaluated [6]. In this respect the model of sawmill was advantageous, because it allowed eliminating other yield influencing factors, except positioning errors.

Therefore, seeking to ascertain the peculiarities of the impact of offset, in the present paper studies were conducted in real sawmills, while for the studies of its influence a sawmill simulation model was used. This program help to optimize volume and value yield of sawn timber, taking into account the shape and dimensions of logs, sawing patterns, allowable wane, sawing kerf, process of raw materials, etc.

2. EXPERIMENTAL

The object of studies – offset, described as the discrepancy between log axis and the axis of sawing patterns. Figure 1 presents measurement scheme of offset for cant sawing [11].

The offset of log was calculated using following equation:

$$E = \frac{A^2 - B^2}{8 \times H}, \tag{1}$$

where D_{top} is the log top end diameter, mm; E is the offset, mm; H is the heigth of cant, mm; A is the width of cant in one side, mm; B is the width of cant in another side, mm.

Diameter formula:

$$D_{top} = \sqrt{S^2 + \frac{(A^2 + B^2 + 2 \times H^2)}{8}} \tag{2}$$

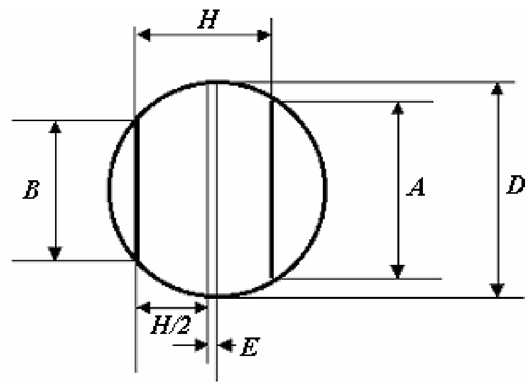

Fig. 1. Scheme of the offset measurement

The offset is ascertained by measuring the widths of cant sides in the same places of both cant sides (A, B, C, D) after primary sawing (Fig. 2 and Fig. 3).

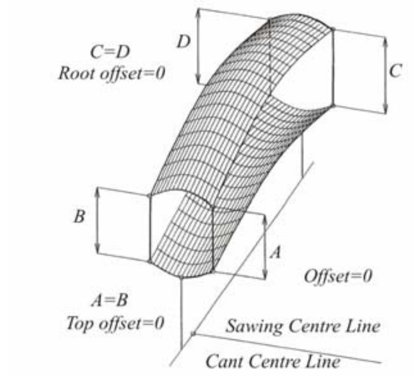

Fig. 2. Log position and cant dimensions without offset

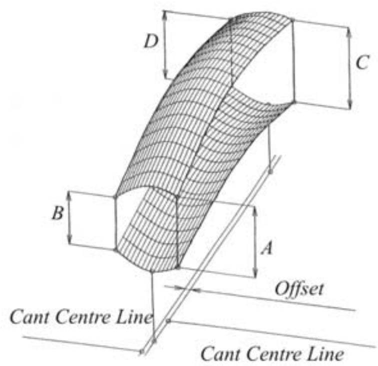

Fig. 3. Log position and cant dimensions with offset

The preciseness of log positioning in respect of sawing patterns may be studied in real sawmills, measuring dimensions of sawn cants and calculating offset. Logs of 12 – 16 cm in diameter and 2.4 as well as 3.6 m in length were studied sawing of cants in height 98 mm. To ascertain the size of offset, a series of studies were conducted in different sawmills of Lithuania. Logs and cants of 2.4 and 3.6 m of aspen, alder, spruce, pine and larch were measured and offsets were calculated according to (1). The values of offsets obtained in real sawmills were further applied in theoretical evaluation of volume yield changes.

It is impossible to ascertain quite precisely the influence of offset on final yield. Due to that a sawmill simulation model was used, in which neither technological nor other factors, by exception of offset influence volume yield changes.

Optimal saw patterns were ascertained for different top diameters D = 14, 16 ... 32 cm. The influence of offset E on optimal cant pattern for different top diameters was studied, log length was L = 5 m, while tapering T corresponds to log parameters, kerf width was b = 4 mm. Offset E varied from 0 to 12 mm.

3. RESULTS AND DISCUSSION

Field-testing in the sawmills showed, that offset varies in the range 0 to 10 mm in the both sides of the mean value. The dispersion of offset corresponds to the normal Gauss's distribution law (Fig. 4). Mean of the values of positioning errors x = – 0.35, dispersion s^2 = 4.35, coefficient of asymmetry 0.26. Thus it can be stated, that the positioning equipment was adjusted properly. Fig. 4 presents values of distribution.

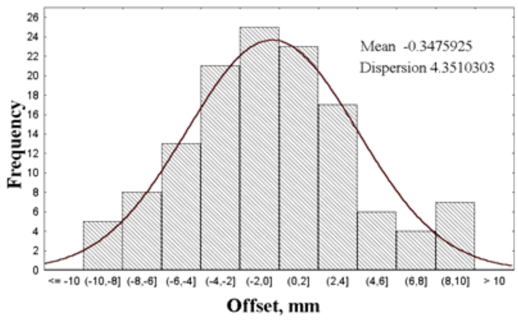

Fig. 4. The histogram of offset dispersion and normal curve

On the side towards which the patterns shift, the width of boards decreases (the first and the second board in the sawing pattern) and the length becomes shorter, while the widths of boards on the opposite side (the fourth and fifth board in the sawing pattern) and that of the central board (third board in the sawing pattern) increase. It was observed, that offset has the greatest influence on thin logs, and then it decreases, but remains sufficiently significant.

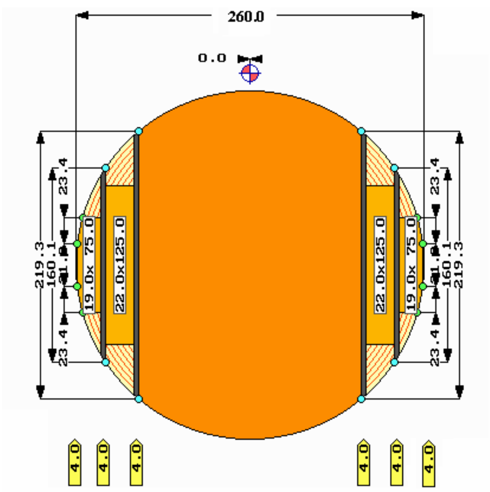

Fig. 5. Log croos-section without offset. Log length 5 m, top end diameter 26 cm and taper 1 cm/m. Volume yield Y = 60.58 %

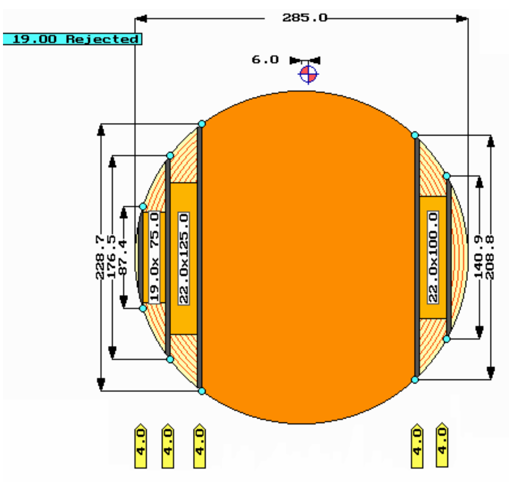

Fig. 6. Log cross-section with offset E = 6 mm. Log length 5 m, top end diameter 26 cm and taper 1 cm/m. Volume yield Y = 58.69 %. One board (19 mm thickness) was rejected

The studies have shown that after introduction positioning error saw patterns become asymmetric and are transformed in respect of the width of boards (Fig. 5 and Fig. 6).

The first sideboard sawn from the taper zone increases in length, when E = 6 mm and bigger, the width of this board changes and increases by one nominal dimension, but the board becomes shorter. The second sideboard remains of the same length and width, while increase of positioning error value results on the width increases by one nominal dimension. The third and fourth boards in the sawing pattern become shorter, while further increase of E decreases the width by one nominal dimension.

When small logs are sawn, then the sideboard is discarded, because there exist restrictions on nominal dimensions of the width and length (the width of a board cannot be less than the allowable least nominal dimension – 75 mm, and not shorter than 1.2 m). Under higher diameters (from D = 20 cm), sideboard, though falls within the set, but becomes shorter. Already under low E value (up to 4 mm) the yield observably decreases, although nominal dimensions of cross-sections of boards remain unchanged (changes only the length). When E equal to 6 – 8 mm, nominal dimensions of boards also changes, while depending on top end diameter yield decreases from 0.18 to 4.83 %.

It must be stated, that all calculations were done when board wane is not allowed. Having calculated optimal patterns under 30 % allowable wane it was found, that for thin logs side boards would not have been discarded, but undesired wane would appear, which are restricted to the quality and also decrease value of yield.

The differences of yields of optimal sets for each top diameter are given in Fig. 7 (initial yield – for E = 0, differences when E = 6 and E = 12 mm).

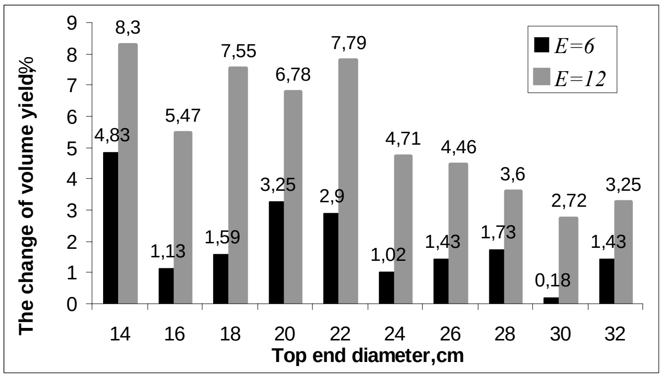

Fig. 7. The differences in the yields for optimal sawing patterns under different top diameters, when E is equal to 6 and 12 mm

Figure 7 shows that the dependences of optimal yields, evaluating the diameters and tapers of real logs, are of teeth-like changeable character. It shows, that in certain diameter intervals nominal dimensions correspond to the given ones and the differences of volume yields from their values under E = 0 mm are minimal. E.g., when D = 30 cm and E = 6 mm, this difference fails to exceed 0.18 %. However, when E = 6 mm, yield changes sawing logs of small dimensions are rather high (when D = 14 cm, they will comprise 4.83 %). Thus precise positioning is especially important if logs up to 20 – 22 cm to be efficiently sawn. Differences decrease starting from

D = 24 cm, but even here they reach 1.02 – 1.73 %, when E is equal to 6 mm and 2.72 – 4.71 %, when E is equal to 12 mm.

However, positioning errors have the greatest influence not only on volume and value yields, but also on the dimensions of sawn boards. Due to dimensional changes it is difficult to fulfill the requirements of customers concerning desirable specifications of boards in respect of their cross-section and length dimensions. The boards become shorter, although volume balance remains unchanged. It is even worse, if is needed boards of a certain length. Even under small offset boards of desirable length cannot be sawn. Therefore, offset in this respect has the more significant influence on specification and value yield.

3.CONCLUSIONS

1. Positioning error has the greatest influence for small-sized logs. Its augmentation leads to the pattern transformations in respect of board width shift to one or another side. Even with allowable wane, due to positioning error it can be too high for boards of the best quality, i.e. sawn, from the central part of a log.
2. Depending on log top end diameter each 4 mm positioning error increment reduces sawn timber volume yield from 0.7 to 1.5 %.
3. Total decrease of volume yield for 14 – 32 cm log diameters was within intervals 0.18 – 4.83 % and 2.72 – 8.3 %, when offset E consisted 6 and 12 mm respectively.
4. For optimal patterns no regularities concerning positioning error influence on the changes of volume yield values were found. Positioning error “hides away” due to the discreteness of basic sizes. Positioning error influences not only sawn timber volume yield, but also most of all specificational and value yield, because boards of desired lengths and cross-sectional measurements are not obtained.
5. The offset influences not only sawn timber volume yield, but value yield and nominal dimensions of falling boards, also.
6. The greatest influence of all the above-mentioned factors is observed on small-sized logs (14 – 20 cm). As far as the number of such logs processed in sawmills comprises about 31 %, it is especially important to apply specialized efficient equipment, taking into account the influence of all technological factors. Most useful here would be technologies with positioning and curved-lined sawing possibilities, resulting in small log parallel and angle dislocation.

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