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EFFECTIVE ACTIVE TIME OF LIMBING AND CONVERSION AT CHAINSAW USE IN SELECTED TECHNOLOGY AND HABITAT VARIANTS

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Abstract. The time within which, accordingly to its application, machine works, and an object of work and working groups are under load, is the effective active time. The purpose of the research was the order statistics of effective active time of limbing and conversion at chainsaw use in two technology and two habitat variants. The effective active time of limbing and conversion of one tree was most frequently from 0.5 s to 10.49 s in variant in which the limbing included tree crowns and only thicker branches cutting and the conversion included rods meant for chipping. The strong tree's branching in fresh mixed coniferous forest had influence on the prolonged limbing time. The share of S_{2a} assortment in total volume of harvested wood had influence on the conversion time, besides the number of wood assortment cutting.

Key words: limbing, conversion, effective active time, pine stands

INTRODUCTION

The effective active time of limbing and conversion at chainsaw, use is the time, within which accordingly to its application chainsaw works (cuts off the tree from stump, branches and tree crowns, divides trunk, etc.) and working groups are under load [Glazar and Wojtkowiak 2009, Laurow 1999].

Wood cutting at chainsaw use is usually realised at carburetor throttle maximum opening, and the grave rotational speed of engine is achieved thanks to relevant feed force induction [Więsik and Wójcik 2007].

Such work is observed, among others, during tree brunches and crowns cutting, at the time of limbing procedure, and wood assortment cutting, within the process of conversion.

The work of chainsaw on running light, within which chain is immobilized and engine speed is constant, is the work without load [Wojtkowiak et al. 2007 a, b]. During limbing and conversion operations, walking of the operator from one tree to another,

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with the chainsaw engine on, is described as chainsaw work without load and according to BN-76/9195-01 standard is subsidiary time.

The effective active time of realised technology or its part (operation) is the category time, within which the machine and operator are actively involved in either technology or operation. A detailed analysis of the effective active time can be helpful at planning of technology realisation [Glazar 2013, Glazar and Bocianowski 2012].

The purpose of the research was the order statistics of effective active time of limbing and conversion at chainsaw use in two technology and two habitat variants.

MATERIAL AND METHODS

The research was carried out in pine stand, in which II and III age class thinning was executed. The four experimental sites were situated in Kliniska, Krzystkowice and Wejherowo Forest Division. The basic features of the test areas are presented in Table 1.

Table 1. Basic features of research areas
Tabela 1. Podstawowe cechy taksacyjne powierzchni wybranych do badań

Number of area Numer powierzchni	1	2	3	4
Regional State Forest Directorates RDLP	Szczecin	Szczecin	Zielona Góra	Gdańsk
Forest division Nadleśnictwo	Kliniska	Kliniska	Krzystkowice	Wejherowo
Forest District Leśnictwo	Załom	Załom	Mokrzyce	Rekowo
Compartment Oddział	450c	449c	220d	180a
Dimension of area, ha Wielkość powierzchni, ha	0.45	0.47	0.62	0.45
Forest site Siedlisko	Bśw	Bśw	Bśw	Bmw
Share of species Udział gatunków	So	So	So	7So2Św1Md
Age Wiek	41	41	47	22
Stand quality class Bonitacja	II	II	II	I
Average d.b.h., cm Przeciętna pierśnica, cm	10	10	16	11
Average height, m Przeciętna wysokość, m	12	12	11	9
Stand density index Zadrzewienie	0,9	0,9	0,9	0,8
Stand quality Jakość	22	23	23	22

The limbing and conversion operations were carried out with chainsaw Husqvarna 346XP (1, 2, 3 areas) and Husqvarna 357XP (4 area).

On 1, 3, 4 surfaces, limbing consisted of tree crowns and all branches cutting (limbing was led on a level with the wood surface or leaving 3 cm long knags). On surface 2, the limbing included tree crowns and only thicker branches cutting off.

The limbing was carried out applying pendulous method, on both surfaces. Two technological variants were used in the conversion operation. The first variant included rods conversion (length of about 4.50 m) meant for chipping (M_1, S_{3a}). The second variant included rolls (length 2.40 m – S_{2a} assortment) and rods conversion (M_1) also meant for chipping, and was used for thick trees. The first variant was applied in all surfaces, the second on surfaces 1, 3, 4.

The effective active time of limbing and conversion, i. e. the time of the chainsaw guide bar contact with the tree branch to be cut first, to dismissing the bar after completion of limbing and conversion (most frequently it was the tree crown that was cut off), was analysed. The limbing and conversion effective active time measurement was led with the aid of stop watch, and the accuracy was 0.01 second.

The structure analysis of the researched statistical population of cut trees, from the point of view of statistic feature – effective active time of limbing and conversion, was performed on the basis of order statistics.

Distribution was characterised by location, spread and shape.

The following descriptive parameters were used to statistical analysis:

– median (Me), mode interval, quartiles (Q_1, Q_3)
– quartile deviation (Q), coefficient of variation (V_Q)
– skewnees coefficient (A_s).

RESULTS OF INVESTIGATIONS

The basis quantities characterising researched statistical population of cut trees, from the point of view of statistics feature – effective active time of limbing and conversion are presented in Table 2.

From the investigative surfaces (1-4) 1735 trees were removed. In total, 44 m^3 wood for chipping (M_1, S_{3a}) and 10 m^3 assortment S_{2a}, were harvested.

The removed tree in thinning was statistical unit. The effective active time of limbing and conversion of one tree was most frequently from 10.5 s to 20.49 s on surfaces 1 and 3, from 0.5 s to 10.49 s on surface 2, and from 30.5 to 40.49 s on surface 4. In variant 1 (the limbing included cutting of trees crowns and all branches) half the population had values of limbing and conversion time lower than: on surface 1 – 21.76 s, 3 – 29.42 s and 4 – 39.70 s, in variant 2 in which the limbing included tree crowns and only thicker branches cutting (2 area), lower than 5.57 s. According to the statistical analysis of quartiles, 25% of the data was lower (or equal) than 16.04 s and 75% of the data was lower (or equal) than 27.12 s, on surface 1. On surfaces 2-4: 3.18 s and 8.75 s, 17.99 s and 54.56 s, 24.50 s and 56.75 s, respectively.

The average deviation from the middle half of a distribution was 5.538 s, on surface 1, 2.785 s – 2, 18.283 s – 3, and 16.125 s – 4. It gives bases to ascertain, that the cut trees were moderately statistically diversified from the point of view of effective active time of limbing and conversion, on 1-2, 4 surfaces (on surface 3 – strongly).

Table 2. Basic quantities characterising researched statistical populations – cut trees, from the point of view of statistic feature – effective active time of limbing and conversion
Tabela 2. Podstawowe wielkości charakteryzujące badane zbiorowości statystyczne ze względu na wybraną cechę – efektywny czas okrzesywania i przerzynki

Number of area Numer powierzchni	1	2	3	4
Volume of harvested wood, m^3 Ilość pozyskanego surowca, m^3				
M_1, S_{3a}	14	15	12	3
S_2	3	–	6	1
Number of removed trees, pcs Liczba usuniętych drzew, szt.	572	669	356	138
Average volume of one tree, m^3 Przeciętna miąższość usuniętego drzewa, m^3	0.03	0.02	0.05	0.03
Total effective active time of limbing and conversion for all trees, s Suma efektywnego czasu okrzesywania i przerzynki wszystkich drzew, s	12 859.53	4 520.04	14 109.25	6 146.20
Minimal effective active time of limbing and conversion, s Minimalny efektywny czas okrzesywania i przerzynki, s	6.87	0.64	5.03	8.00
Average effective active time of limbing and conversion, s Średni efektywny czas okrzesywania i przerzynki, s	22.448	6.756	39.185	48.39
Maximal effective active time of limbing and conversion, s Maksymalny efektywny czas okrzesywania i przerzynki, s	125.16	38.47	163.57	153.00
Mode interval, s Przedział dominanty, s	10.5-20.49	0.5-10.49	10.5-20.49	30.5-40.49
Median, s Mediana, s	21.76	5.57	29.42	39.70
Quartile Q_1, s Kwartyl Q_1, s	16.04	3.18	17.99	24.50
Quartile Q_3, s Kwartyl Q_3, s	27.12	8.75	54.56	56.75
Quartile deviation Q, s Odchylenie ćwiartkowe Q, s	5.538	2.785	18.283	16.125
Coefficient of variation V_Q, % Współczynnik zmienności V_Q, %	25.45	50.00	62.13	40.62
Skewnees coefficient A_s Współczynnik asymetrii A_s	–0.01	0.10	0.37	0.06

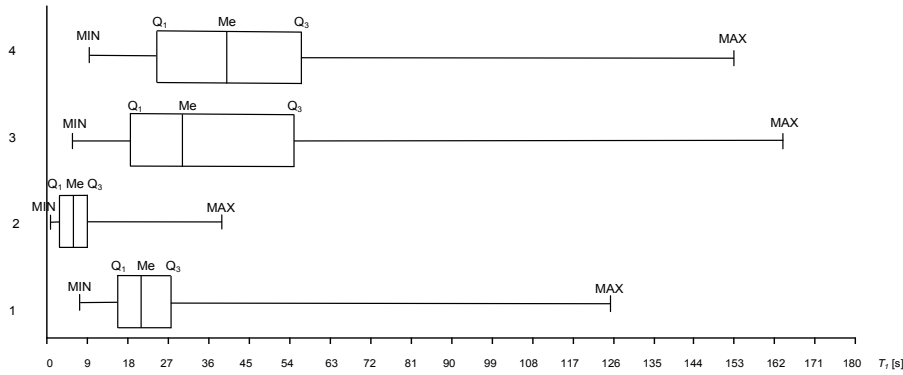

Fig. 1. Distribution of effective active time of limbing and conversion for research areas 1-4: Q_1, Q_3 – quartiles, Me – median, MIN – minimal effective active time of limbing and conversion, MAX – maximal effective active time of limbing and conversion

Rys. 1. Rozkład efektywnego czasu okrzesywania i przerzynki dla wszystkich powierzchni badawczych: Q_1, Q_3 – kwartyle, Me – mediana, MIN – minimalny efektywny czas okrzesywania i przerzynki, MAX – maksymalny efektywny czas okrzesywania i przerzynki

The negative skewnees coefficient qualifies the distribution of effective active time of limbing and conversion as weak left-side asymmetry on surface 1. The positive skewnees coefficient qualifies the distribution of effective active time of limbing and conversion as weak right-side asymmetry on surfaces 2 and 4 (on surface 3 – moderately).

Distributions of effective active time of limbing and conversion in all surfaces are presented in Figure 1.

DISCUSSION

In first thinnings of pine stands mainly slash wood, in the form of pole lumber, and medium size wood, in the form of stake wood, most frequently 2.40 m long, as well as perches wood (S3) is harvested.

The round timber for trade undergoes obligatory limbing. There are four classes of limbing: very good, good, sufficient and rough, for wood meant for chipping [Pilarki... 2002].

A chainsaw is the basic device used in first thinnings, in activities such as tree limbing and conversion [Chmielewski and Porter 2012, Glazar and Bocianowski 2012, Maciak 2010].

The limbing and conversion can be led in two technological variants. In variant 1, all operations (felling, limbing and conversion) are executed on each tree by turns. In variant 2, only one operation (felling, limbing or conversionon) is executed on each tree. In polish reality variant 1 is executed most often [Wójcik 2007]. The first variant was executed on the research surfaces, too.

The time of limbing and conversion depends also on technical parameters of the harvested trees, on volume, number of removed branches and number of wood pieces cutting, within the conversion [Wójcik 2007].

From the researched old pine stands with 1.99 ha dimension of area, 1735 trees were removed. That corresponds to the cutting intensity of Jodłowski's [2000] investigation surfaces in pine stands – number of removed trees – 1120 pcs/ha, average volume of one removed tree was about 0.03 m^3, age – 29-35 years old.

The effective active time of limbing and conversion, within which chainsaw working groups were under load, was analysed. Neither the time of the operator walking from tree to tree with a working chainsaw engine, nor the time of the operator's adjusting position before starting of limbing and conversion, were analysed.

The time of limbing and conversion by Wójcik [2007] was analysed. According to Wójcik [2007] the effective active time of limbing of one tree, about 5.9-61.0 cm diameter at breast height, was from 33 s to 437 s, and the effective active time of conversion from 7 s to 240 s. The number of removed branches influences the limbing time and the number of wood assortment cutting the conversion time Wójcik [2007].

The results of investigations verify this opinion. The strong tree's branching in fresh mixed coniferous forest (phot. 1, phot. 2 to comparison) had influence on the prolonged limbing time.

The share of S_{2a} assortment in total volume of harvested wood had influence on the conversion time, beside the number of wood assortment cutting (S_{2a} assortment logging is more time-consuming than other assortments). The share of S_{2a} assortment was: 33% on surfaces 3 and 4, 18% on surface 1, on surface 2 not harvested.

The effective active time of limbing and conversion by Więsik [2001] was analysed, too. In a 60-year old pine stand, within the executed thinning, the effective active time of limbing and conversion of trees of about 15.8 cm average diameter at breast height and 0.18 m^3 average volume, was over 90 s and over 180 s, respectively.

The knowledge of time of wood harvesting particular operations enables to show the most dangerous operations from the point of view of different stressors (vibration, noise, exhaust gas, physical and mental load) [Wójcik 2007].

Phot. 1. Stand on surface 4 before thinning
Fot. 1. Drzewostan na powierzchni 4 przed zabiegiem trzebieży

Phot. 2. Stand on surface 1 before thinning
Fot. 2. Drzewostan na powierzchni 1 przed zabiegiem trzebieży

The joint time, within which the operator works with the chainsaw in shift time, has a great importance from the point of view of ergonomics [Stempski 2007]. The proper planning of technologies should always take into consideration the proper configuration of breaks in total working shift time [Sowa et al. 2007].

CONCLUSIONS

1. The time of limbing and conversion depends on technical parameters of the harvested trees, on volume, number of removed branches and number of wood pieces cutting, within the conversion.
2. The effective active time of limbing and conversion of one tree was most frequently from 0.5 s to 10.49 s in variant in which the limbing included tree crowns and only thicker branches cutting and the conversion included rods meant for chipping. Half the population had values of limbing and conversion time lower than 5.57 s. These were the lowest values obtained in the tests carried out. Also, the spread between the minimum and maximum time was the smallest (37.83 s).
3. The strong tree's branching in fresh mixed coniferous forest had influence the prolonged limbing time.
4. The share of S_{2a} assortment in total volume of harvested wood had influence the conversion time, beside the number of wood assortment cutting.

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ANALIZA EFEKTYWNEGO CZASU OKRZESYWANIA I PRZERZYNKI DRZEW Z UŻYCIEM PILARKI SPALINOWEJ W WYBRANYCH WARIANTACH TECHNOLOGICZNYCH I SIEDLISKOWYCH

Streszczenie. Czas efektywny jest czasem, w którym urządzenie obrabia bądź przetwarza zgodnie z przeznaczeniem przedmiot pracy, a zespoły jego robocze znajdują się pod obciążeniem. Celem badań była analiza efektywnego czasu okrzesywania i przerzynki drzew z użyciem pilarki spalinowej, w dwóch wariantach technologicznych i w dwóch

wariantach siedliskowych, na podstawie wybranych pozycyjnych parametrów opisowych. Efektywny czas okrzesywania i przerzynki w wariancie z okrzesywaniem prowadzonym w sposób zgrubny i wyrabianiem jedynie surowca przeznaczonego do zrębkowania najczęściej osiągał wartości z przedziału 0,5-10,49 s. Na siedlisku BMśw silne ugałęzienie drzew wpływało zdecydowanie na wydłużenie czasu operacji okrzesywania. Z kolei na czas przerzynki, poza liczbą wyrabianych sortymentów, miał wpływ udział sortymentu S_{2a}, którego wyróbka zajmowała więcej czasu w porównaniu z pozostałymi sortymentami.

Słowa kluczowe: okrzesywanie, przerzynka, czas efektywny, drzewostany sosnowe

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