Original scientific paper – *Izvorni znanstveni rad*

Analysis of Factors Affecting Log Band Saw Capacity

Josip Ištvanić, Ružica Beljo Lučić, Matija Jug, Rajka Karan

Abstract – Nacrtak

The goal of this research was to measure the capacity of the log band saw by monitoring the sawing process per operation for each log and to determine what the influencing factors were and their effect on the technological capacity of the log band saw, based on recorded and processed data.

The analysis of the recorded data shows that the processed log volume, whose increase also increases the saw capacity, has the most important effect on log band saw capacity.

It is imperative to take into account the volume of logs being processed when calculating the capacity of the log band saw. When monitoring the work of the operator, the use of fixed norms is not recommended and it is imperative that norms are connected to the volume of logs being processed.

Keywords: log band saw, capacity, sawmill, sawing, norms

1. Introduction – *Uvod*

The classic one-blade vertical band saw is the most commonly used machine for processing logs in Croatian sawmills. By classic band saw the log is fastened with corresponding hooks on separate carriages. After each sawing operation is complete, the carriage returns to the start position in front of the saw blade setting the board thickness and the sawing operation is repeated (Fig. 1).

According to Brežnjak (2000), maximum log diameter for sawing is not limited with the log band saw. The most important positive characteristic of the log band saw is its ability to saw each log individually. This means that each log can be sawed in a manner that best suits its dimensions and qualitative features, which results in better log quality and value yield. The log band saw can also saw curved logs with relative success. Sawing boards individually also means simpler transportation and possible storage before next operations. More importantly, this way of log sawing uniformly and continuously loads the machine for secondary processing. Due to an approximately constant saw speed, as well as speed of carriages (i.e. feed speed), the processing of logs with band saw is calm, less noisy and with less influence of inertia forces on the environment than the processing with frame saws.

The saw blade of the log band saw is thinner than the one on the frame saw or circular saw, which results in less saw kerf width and a greater log quantity yield. Considering that the net cutting power of sawing is in proportion with the saw kerf width, the individual net energy normatives are also smaller. With proper saw blade preparation and corresponding parameters of sawing, the quality of the sawed surface is better and there is significantly less edge tear-out than would be the case if the frame saw were used. This is the result of a relatively big cutting speed on log band saw in comparison with the frame saw, and more recently, of the common practice of swaging-set teeth of band saw blade, which is rarely used on the frame saw blade.

It is commonly said that the basic disadvantage of the log band saw is the complicated preparation of tools and machine handling compared to the frame saw or circular saw. In addition, sawing slabs is more difficult on log band saw due to the hooks used for fastening logs on the carriage. Also, sawing accuracy is less because of lower saw blade thickness and it is influenced by free saw blade length, characteristics of saw blade guides and the saw blade preparation.

Fig. 1 One-blade vertical log band saw
Slika 1. *Jednolisna okomita tračna pila trupčara*

The capacity of the log band saw depends on a number of factors. Aleksov and Vukićević (1988) concluded that there is a correlation between the time it takes to process fir/spruce logs on the log band saw and the log's diameter, length and volume. They also concluded that there is a correlation between the processing time and the manufacturing technology and sawing parameters.

According to Vukičević (1989), due to the complicated process of sawing on the log band saw it is necessary to analyze and measure the duration of each partial operations of the sawing process. Special importance should be given to the operation of sawing. Research on hypothetical cases showed that feed speed during sawing operation is not a defining dimension which, by definition, should be the case. Also, the saw kerf height and feed speed were not functionally but stochastically dependent. Deviation from the theoretical hypothesis is due to the lack of previously determined optimal parameters for processing and the infeasibility of continuously monitoring the influence of anatomical wood structure on the resistance of sawing and thereby, the speed at which the carriage with the log moves during the sawing process and duration of the sawing operation.

According to Brežnjak and Herak (1973), the most important factor influencing the capacity of the log band saw is the log feed speed. The feed speed is mostly limited by the power unit force, capacity of the tooth gullet area, desired surface quality and accuracy of sawing. When the tooth gullet area is overfilled, the sawdust goes into the saw kerf between the saw blade and the lateral saw surfaces, which causes additional resistance that increases the tools temperature and reduces stability. This also reduces the quality of the processed surface. When sawdust is »glued« to the edge of the wheel it causes vibration and increases the amplitude of lateral movements. It is recommended that the maximum volume of the gullet area filled with sawdust should not be greater than 80%, which limits the log feed speed. With greater log feed speed, i.e. bite per tooth, the capacity of band saw increases linearly. Increasing the feed speed (bite per tooth) above the limit values makes worse all sawn-wood quality indicators such as accuracy of sawn board thickness, roughness of the sawn surface, wooliness and edge tear-out. Consequently, each sawmill with certain work environments, should test and determine the limit values for feed speed that would allow for satisfactory and accurate sawn-wood thickness and satisfactory quality of the processed surface.

The capacity of log band saws are most often expressed as the volume of processed logs per hour, per shift, daily, monthly and annually according to predetermined formulas.

Technical capacity of log band saws is the effective log band saw capacity in a time unit (most often per hour) without taking into account additional time for machine maintenance, unforeseen interruptions, breakdowns, etc. If additional time is taken into account then we are speaking about the exploitation capacity of the log band saw that is most often expressed as the volume of processed logs per shift.

The goal of this research was to measure the technical capacity of the log band saw in real production condition by monitoring the entire sawing process per separate operation and to determine what the influencing factors were and their effect on the technological capacity of the log band saw, based on recorded and processed data.

2. Material and methods – *Materijal i metode*

The study is based on logs cut from sessile oak (*Quercus petraea* L.) located in central Slovenia. The logs were graded according to Croatian standards HRN EN 1315-1 and HRN EN 1316-1.

The primary sawmill in which this study was conducted is located in central Slovenia. The major species sawed in this sawmill are pedunculata oak (*Quercus robur* L.), sessile oak and sweet chestnut (*Castanea sativa* Mill.). Sawmill equipment included a 1400 mm log band saw headrig with automatic hydraulic-operated carriage whose basic technical features are shown in Table 1.

Table 1 Basic technical features of the log band saw
Tablica 1. *Osnovna tehnička obilježja tračne pile trupčare*

Manufacturer *Proizvođač*	Dinaco – Zagreb – Croatia
Year of production – *Godina proizvodnje*	1995
Power unit force – *Instalirana snaga*	75 kW
Wheel diameter – *Promjer kotača*	1400 mm
Type of carriage – *Tip kolica*	Hydraulic
Speed of saw blade – *Brzina piljenja*	32 m/s
Thickness of saw blade – *Debljina lista pile*	1.47 mm
Width of new saw blade *Širina novoga lista pile*	206.4 mm
Length of saw blade – *Duljina lista pile*	min. 9300; max. 9720 mm
Tooth pitch – *Korak ozubljenja*	45 mm
Tooth shape – *Oblik ozubljenja*	PV
One side swage-set of saw teeth *Jednostrano proširenje zubaca stlačivanjem*	0.3 mm
Rake angle – *Stražnji kut*	17°
Wedge angle – *Kut oštrenja*	56°
Clearance angle – *Prednji kut*	17°

Within the framework of this research, 90 sessile oak logs were sawed. The technique used was complete live sawing. Boards with a thickness of 28 mm were produced. Measurement of processing operations was carried out using a chronometer and these operations were measured in seconds and the cumulative time was recorded after each completed log sawing process. The duration of each individual operation was determined by calculating the difference between two cumulative times. The duration of the following operations was measured:

⇒ t_1 – Loading the log on the carriage
⇒ t_2 – Moving the carriage with the log and setting the sawing position
⇒ t_3 – Sawing
⇒ t_4 – Drawing the carriage away and returning it to the start position
⇒ t_5 – Rotating the slabs
⇒ t_6 – Releasing the last sawn-board
⇒ t_7 – Returning an empty carriage to the start position

The log dimension parameters and duration of the operations were analyzed using descriptive statistics. The total processing time was determined from the measured results. The time and share of each partial operation during sawing process were also determined as well as their influence on the capacity of the log band saw. Microsoft Excel and Statistics software were used to analyze these data.

The capacity of the log band saw was calculated for each sawing based on the log volume and the time required for its processing according to equation (1).

$$C_{\mathrm{lbs}} = \frac{V_{\log}}{\sum t} \cdot 3600 \qquad (1)$$

Where:

C_{lbs} Capacity of the log band saw, m^3/h
$V_{\log}$ Log volume, m^3
$\sum t$ Total time (sum of time necessary just for sawing and time necessary for all supporting operations during sawing), s

3. Results and discussion – *Rezultati i diskusija*

The parameters of sawed logs and the operation time are shown using descriptive statistics in Table 2.

Most time is spent on the actual log sawing process. Unavoidable manipulation such as returning the carriage, shifting the log to the next board thickness and drawing the log away from the saw also takes a lot of time in the process (Fig. 2).

Table 2 Descriptive statistics of dimensions for sawed logs, operation time and capacity

Tablica 2. *Deskriptivna statistika dimenzija raspiljenih trupaca, vremena operacija i kapaciteta*

Parameter – *Parametar*	Minimum *Najmanja vrijednost*	Maximum *Najveća vrijednost*	Median *Medijan*	Mean *Aritmetička sredina*
Log length – *Duljina trupca*, m	2	4.2	2.7	2.771 ± 0.537
Mid diameter – *Srednji promjer trupca*, cm	25	53	35	36.622 ± 6.622
Log volume – *Obujam trupca*, m^3	0.127	0.664	0.261	0.287 ± 0.129
Time of loading the log on carriage, s *Postavljanje trupca na kolica*, s	2	28	5	5.97 ± 4.17
Time for moving the carriage with the log and setting the sawing position – *Vožnja kolica i zauzimanje položaja za piljenje*, s	32	124	64.5	67.37 ± 18.63
Sawing time – *Piljenje*, s	61	352	118.5	132.07 ± 50.78
Time for drawing the carriage away and returning it to the start position – *Odmak i povrat kolica u početni položaj za piljenje*, s	27	114	59	61.87 ± 19.60
Time of slab rotation – *Okretanje okorka*, s	4	33	8	9.08 ± 4.13
Time for releasing the last sawn-board, s *Otpuštanje zadnje piljenice*, s	1	17	2,5	3.11 ± 2.16
Time of returning an empty carriage – *Vožnja praznih kolica u početni položaj za postavljanje trupca na kolica*, s	2	42	10	10.33 ± 4.25
Time required for a complete sawing cycle (sawing and manipulation) *Ukupno vrijeme (piljenje i manipulacija)*, s	144	517	277	289.78 ± 83.80
Time required for manipulation – *Ukupno vrijeme manipulacije*, s	77	266	154	157.71 ± 39.62
The share of manipulation in total time, % *Udio vremena manipulacije u ukupnom vremenu*, %	31.91	66.12	55.65	55.26 ± 5.66
Log feed speed – *Posmična brzina trupca*, m/min	7.67	22.87	15.71	15.40 ± 2.78
Log band saw capacity – *Kapacitet tračne pile trupčare*, m^3/h	2.240	5.872	3.273	3.474 ± 0.789

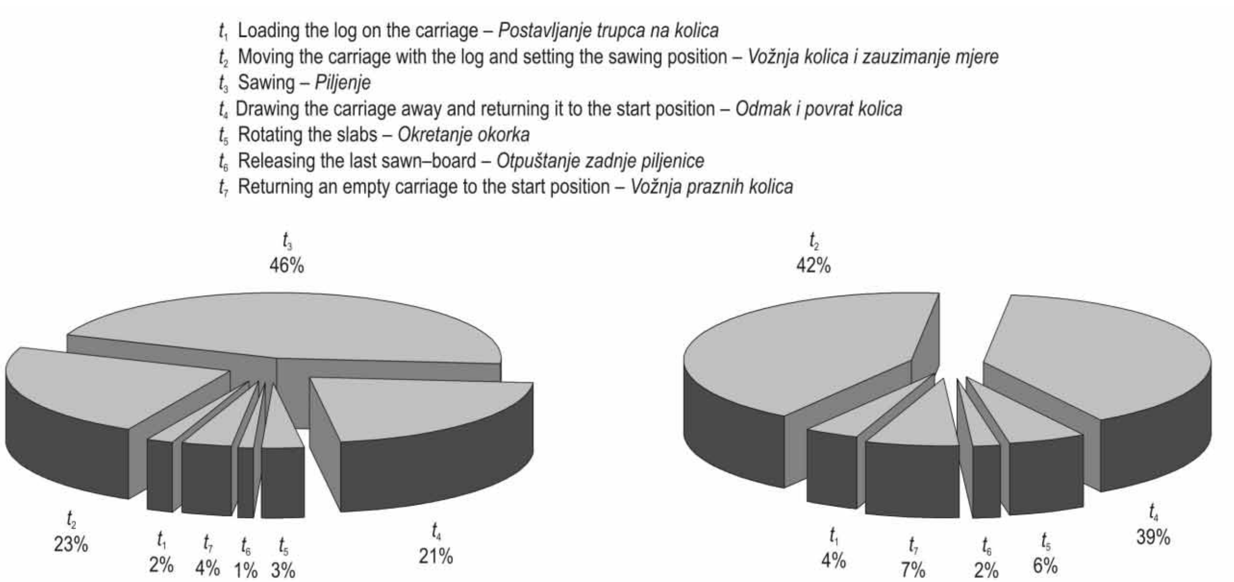

Figure 2 Proportion of time required for each individual operation in the total time of sawing process

Slika 2. *Udjeli vremena trajanja pojedinih operacija u ukupnom vremenu piljenja*

Fig. 3 Share of time needed for each operation in the total manipulation time for sawing logs

Slika 3. *Udjeli vremena trajanja pojedinih operacija u ukupnom vremenu manipulacije pri piljenju trupaca*

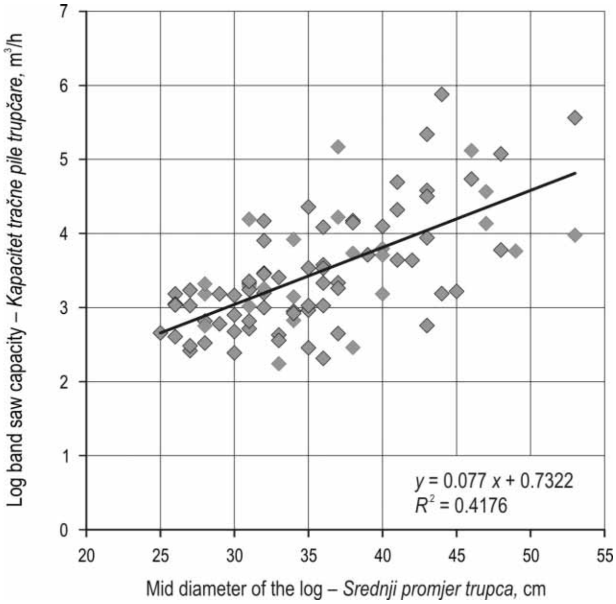

Fig. 4 Log band saw dependence capacity on log mid diameter

Slika 4. *Ovisnost kapaciteta tračne pile trupčare o srednjem promjeru trupaca*

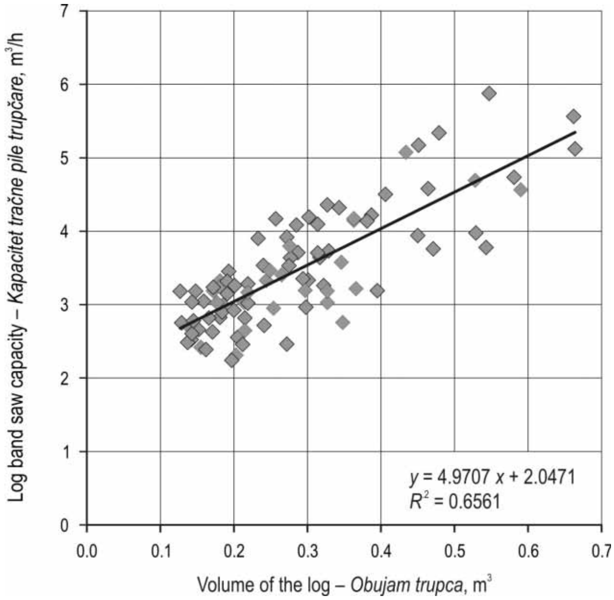

Fig. 6 Log band saw dependence capacity on log volume

Slika 6. *Ovisnost kapaciteta tračne pile trupčare o obujmu trupaca*

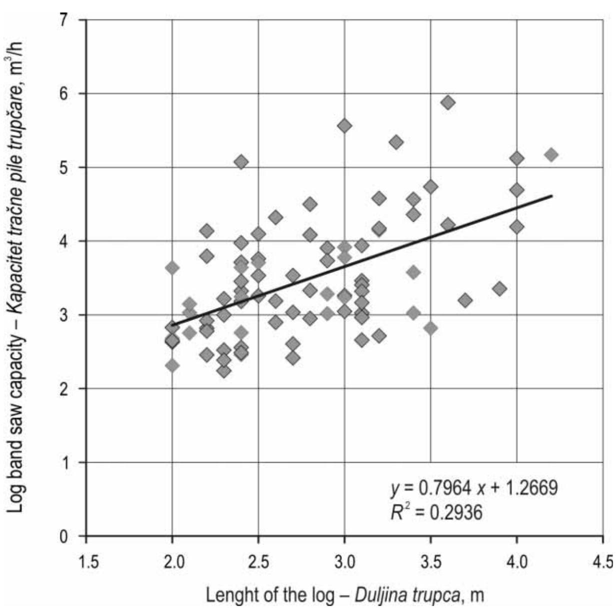

Fig. 5 Log band saw dependence capacity on log length

Slika 5. *Ovisnost kapaciteta tračne pile trupčare o duljini trupaca*

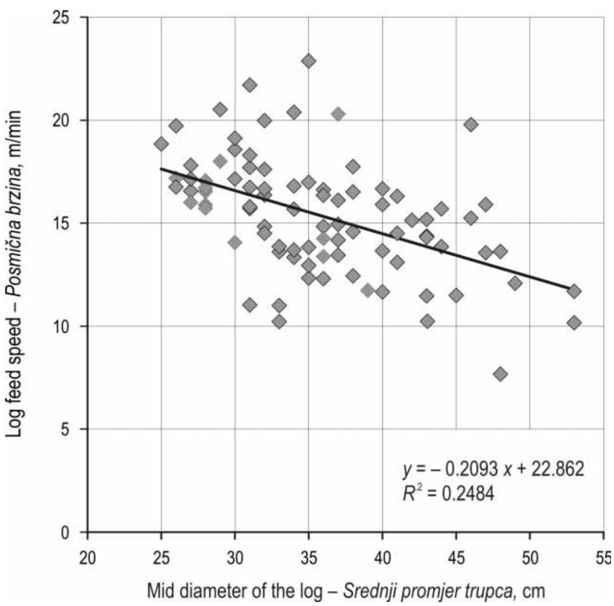

Fig. 7 Dependence of log feed speed on log mid diameter

Slika 7. *Ovisnost posmične brzine o srednjem promjeru trupca*

The reason why so much time is required for manipulation in the sawing process lies in problems related to exclusion and transportation of slabs when starting sawing of logs as well as problems with transportation of sawn boards. The slowness of workers that arrange the boards also contribute to slower manipulation. The operation time required for moving the carriage with the log and setting the sawing position can be shortened by training the machine operator to quickly and precisely arrange the log for the beginning of sawing after loading it on the carriage, and after the slabs are rotated or logs are sawed in half.

According to data that show the time required for each individual operation in the sawing process, the largest share of manipulation time is necessary for

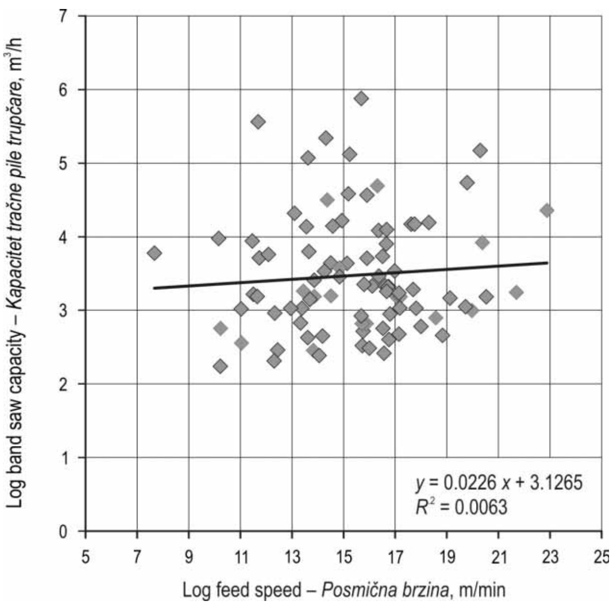

Fig. 8 Log band saw capacity dependence on log feed speed

Slika 8. *Ovisnost kapaciteta tračne pile trupčare o posmičnoj brzini*

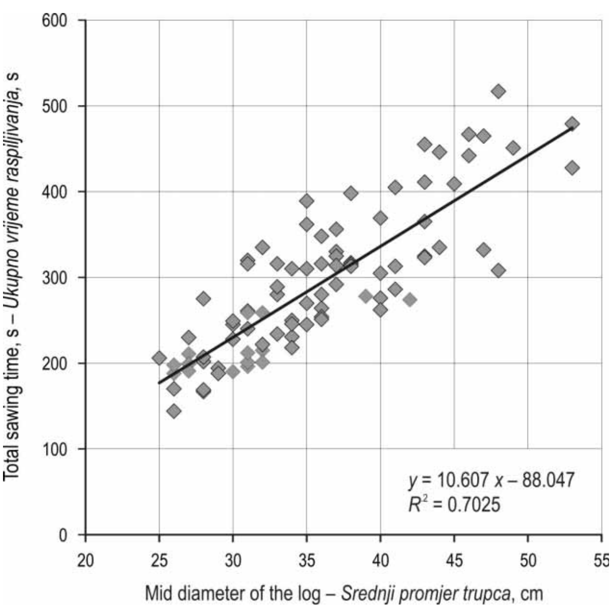

Fig. 9 Dependence of the total sawing time on log mid diameter

Slika 9. *Ovisnost ukupnoga vremena piljenja o srednjem promjeru trupca*

transporting the log on the carriage to the saw blade and setting the sawing position, drawing the log away from the saw and returning the carriage (Fig. 3).

Figures 4, 5, and 6, show the dependence capacity of the log band saw on diameter, length and volume of the processed logs. According to the given dependencies on changes in log band saw capacity, the most influential factor is volume of the log being processed, and the least influential is the length of the log. Even though more time is spent processing logs with a greater length and diameter during manipulation, in the end, these logs achieve greater capacity.

The experiment conducted shows that the log feed speed is reduced with the increase in log diameter (Fig. 7). An increase in log diameter results in greater use of sawing energy. As we know the available power is limited and consequently the log feed speed must be reduced.

Greater log feed speed results in the increased capacity of the log band saw. However, this applies to equal diameter of processed logs. However, in our experiment logs with grater diameter were sawn with lower feed speed and opposite. Thus, when the operator adjusted the log feed speed according to the log diameter, i.e. reduced the log feed speed when sawing logs of greater diameter, the increase in log feed speed did not affect the increase in band saw capacity (Fig. 8).

Therefore, even though logs of larger diameter, i.e. greater volume, are sawed with reduced log feed speed, the log band saw achieves greater capacity and opposite. The effect of log volume on technical capacity of the log band saw is greater than the influence of adjustments in the log feed speed.

Total sawing time is extended with the increase in log diameter due to longer time required for the

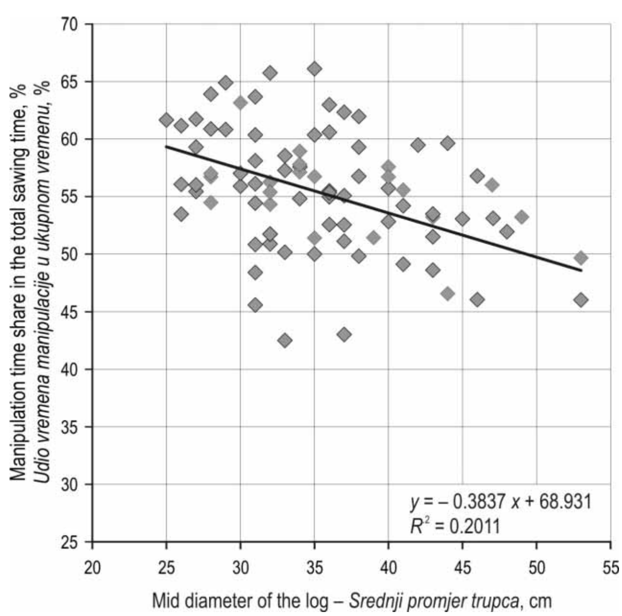

Fig. 10 Dependence of manipulation time share in the total sawing time on log mid diameter

Slika 10. *Ovisnost udjela vremena manipulacije u ukupnom vremenu piljenja o srednjem promjeru trupca*

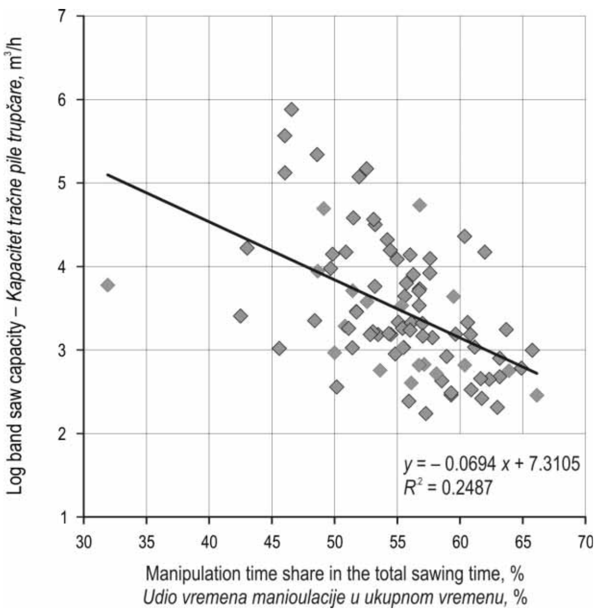

Fig. 11 Dependence of the log band saw capacity on the manipulation time share in the total sawing time

Slika 11. *Ovisnost kapaciteta tračne pile trupčare o udjelu vremena manipulacije u ukupnom vremenu piljenja*

actual sawing caused by a larger number of boards i. e. saw kerfs (Fig. 9).

When logs with grater volume are sawed, the manipulation time share in the total time is reduced and the time share of the actual sawing grows (Fig. 10).

The log band saw capacity drops with the increase of manipulation time share (Fig. 11).

4. Conclusions – *Zaključci*

An increase in manipulation time share in the total sawing time and therefore a decrease in sawing time share results in the reduced capacity of the log band saw. The greatest share in manipulation time takes place during transportation of the log on the carriage to the saw blade and setting the position for sawing and then drawing the carriage away and returning it to the start position.

The analysis of the recorded data shows that the processed log volume, whose increase also increases the saw capacity, has the most significant effect on log band saw capacity.

It is imperative to take into account the volume of logs being processed when calculating the norms and monitoring the work of the operator.

Saw capacity may be increased by reducing the share of manipulation time in the total time of sawing process. The time required for moving the log from the carriage to the saw blade and setting the sawing position may be reduced by additional training of the operator at the control panel.

This research has a limited character, since it refers to a particular dimension and quality of sawlogs and boards. Besides, the sawing method was applied and processing of sawlogs was carried out in the way common for the sawmill where the research was conducted. This fact should be kept in mind when interpreting the results of the research.

5. References – *Literatura*

Aleksov, I., Vukičević, M., 1988: Contribution to investigation of time required for performance on a log band saw. Drvna industrija 39(9–10): 231–233.

Brežnjak, M., Herak, V., 1973: The calculation of the capacity of different saws, equipment and transportation means in sawmills. Drvna industrija 24(9–10): 199–211.

Brežnjak, M., 2000: Pilanska tehnologija drva – I. dio (Sawmilling technology-Part I), Forestry Faculty of Zagreb University.

Vukičević, M. R., 1989: Research work of standard times of operations on a log band sawing machine. Drvna industrija 40(9–10): 191–196.

HRN EN 1315-1, 1999: Dimensional classification – Part 1: Hardwood round timber, 1–5.

HRN EN 1316-1, 1999: Hardwood round timber – Qualitative classification – Part 1: Oak and beech, 1–7.

Sažetak

Analiza utjecajnih čimbenika na kapacitet tračne pile trupčare

Za obradu trupaca u pilanske sortimente u Hrvatskoj se najčešće primjenjuju klasične jednolisne vertikalne tračne pile trupčare. Kako navodi Brežnjak (2000), u pilanama s tračnim pilama trupčarama maksimalni promjer trupca za raspiljivanje nije ograničen. Najvažnija je pozitivna karakteristika tračnih pila trupčara mogućnost individualnoga piljenja svakoga pojedinoga trupca. Tračnim se pilama trupčarama mogu relativno uspješno

raspiljivati i zakrivljeni trupci. Pojedinačnim piljenjem svake piljenice pojednostavljen je sustav transporta i eventualnoga međuskladištenja piljenica. Približno jednaka brzina rezanja te pomak trupca stalnom brzinom omogućuje mirniji i tiši rad, zbog čega je manji utjecaj inercijskih sila na okoliš nego pri radu, primjerice, s jarmačama. List je tračne pile manje debljine nego list jarmače ili kružnih pila, pa je i širina propiljka manja te se postiže veća kvantitativna iskorištenost trupca. Budući da je neto snaga rezanja razmjerna širini propiljka, i jedinični neto energetski normativi su manji. Uz pravilnu pripremu lista pile i odgovarajući režim piljenja, tračnom pilom trupčarom postiže se bolja kvaliteta piljene površine i mnogo manja resavost nego što je slučaj pri raspiljivanju jarmačom.

Kapacitet tračnih pila trupčara ovisan je o nizu čimbenika. Aleksov i Vukičević (1988) utvrdili su postojanje korelacijske veze između vremena obrade jelovih/smrekovih trupaca na tračnoj pili trupčari i promjera, duljine i obujma trupca. Također su utvrdili da postoji i korelacijska veza između vremena obrade i tehnologije obrade te vremena obrade i režima rada.

Prema Vukičeviću (1989) zbog složenosti procesa piljenja trupca na tračnoj pili trupčari nužna je analiza izvršenja i utvrđivanja trajanja izvršenja svakoga zahvata posebno. Ne umanjujući značenje svakoga zahvata posebno, ipak posebno značenje treba dati piljenju trupca s obzirom na to da se radi o tehnološkom zahvatu. Istraživanja na hipotetičkom slučaju pokazala su da visina propiljka i brzina pomaka kolica s trupcem pri piljenju nisu u funkcionalnoj, već u stohastičkoj zavisnosti. Istraživanja su također pokazala da ni ispiljena površina (nezavisno promjenjiva veličina) i trajanje zahvata piljenja trupaca (zavisno promjenjiva veličina) nisu u funkcionalnoj već u stohastičkoj zavisnosti. Uzrok tih odstupanja od teorijskih postavki jest nepostojanje prethodno utvrđenih optimalnih parametara režima obrade i nemogućnost kontinuiranoga praćenja utjecaja građe drva na otpore piljenju, a time i na brzinu pomaka kolica s trupcem pri piljenju i trajanje zahvata.

Prema Brežnjaku i Heraku (1973) najvažniji je čimbenik koji utječe na kapacitet tračne pile trupčare brzina pomaka trupca. Ona je najčešće ograničena raspoloživom snagom pogonskoga motora, kapacitetom pazuha zuba, zahtijevanom kvalitetom piljene površine te točnošću piljenja.

Cilj je provedenoga istraživanja bio izmjeriti kapacitet tračne pile trupčare praćenjem cjelokupnoga procesa obrade po operacijama te na osnovi zabilježenih i obrađenih podataka utvrditi utjecajne čimbenike i veličinu njihova utjecaja na tehnički kapacitet tračne pile. Pod tehničkim kapacitetom tračne pile razumijeva se efektivni kapacitet tračne pile u jedinici vremena (najčešće po satu) bez uzimanja u obzir dodatna vremena za održavanje stroja, nepredviđene zastoje, kvarove i slično.

U sklopu istraživanja raspiljeno je 90 trupaca hrasta kitnjaka (Quercus petraea L.). Piljenje je provedeno tehnikom piljenja ucijelo. Izrađivale su se piljenice debljine 28 mm. Mjerenje je radnih operacija izvedeno kronometrom, mjereno u sekundama, kumulativnim vremenom zabilježenim nakon završetka svake pojedine operacije procesa. Vrijeme trajanja pojedine operacije dobiveno je proračunom razlike dvaju uzastopnih kumulativnih vremena. Mjereno je trajanje sljedećih radnih operacija:

- ⇒ t_1 *– Postavljanje trupca na kolica*
- ⇒ t_2 *– Vožnja kolica s trupcem i zauzimanje položaja za piljenje*
- ⇒ t_3 *– Piljenje*
- ⇒ t_4 *– Odmak i povrat kolica*
- ⇒ t_5 *– Okretanje okorka*
- ⇒ t_6 *– Otpuštanje zadnje piljenice*
- ⇒ t_7 *– Vožnja praznih kolica*

Najviše se vremena troši na sam proces raspiljivanja trupca. Nezaobilazne manipulacije, kao što su povratni hod kolica, pomak trupca za sljedeću debljinu piljenice i odmak trupca od pile, također čine velik utrošak vremena u samom procesu obrade (slika 2).Razlozi su usporene manipulacije problemi vezani uz izuzimanje i transportiranje ne samo okoraka prilikom prvoga propiljka nego i gotovih piljenica te sporost pomoćnih radnika koji slažu piljenice. Vrijeme trajanja operacije vožnje i zauzimanja mjere moglo bi se skratiti uvježbavanjem operatera na stroju da brzo i točno namjesti trupac za početni propiljak nakon nabacivanja na kolica te nakon okretanja okorka ili polovice trupca.

Prema prikazu vremena trajanja pojedinih operacija pri piljenju trupaca najveći udio vremena u ukupnom vremenu manipulacije zauzima operacija vožnje trupca na kolicima do lista pile i zauzimanje mjere te operacija odmaka trupca od pile i povratnoga hoda kolica (slika 3).

Na slikama 4, 5 i 6 iskazana je ovisnost kapaciteta tračne pile o promjeru, duljini te obujmu obrađivanih trupaca. Prema dobivenim ovisnostima na promjenu kapaciteta tračne pile najviše utječe promjena obujma trupca koji se obrađuje, a najmanje duljina trupca. Iako se pri piljenju trupaca većega promjera i duljine više vremena troši na manipulaciju, u konačnici se s trupcima većega promjera postiže veći kapacitet.

U provedenom eksperimentu povećanjem promjera trupca smanjuje se posmična brzina (slika 7). Povećanjem promjera povećavaju se jedinični otpori rezanja, što rezultira većim utroškom električne energije i zahtjevom za povećanjem snage. S obzirom na to da je raspoloživa snaga ograničena, nužno je smanjiti posmičnu brzinu.

Veća posmična brzina utječe na povećanje kapaciteta tračne pile. Međutim, to vrijedi pri jednakom obujmu obrađivanih trupaca. Ta razlika nije signifikantna, ali se može očitati mali pomak u povećanju kapaciteta s povećanjem posmične brzine. Stoga u provedenom eksperimentu, u kojem je radnik prilagođavao posmičnu brzinu prema promjeru trupaca, tj. smanjivao posmičnu brzinu pri piljenju trupaca većega promjera, povećanje posmične brzine nije utjecalo na povećanje kapaciteta tračne pile (slika 8).

Dakle, iako se trupci većega promjera odnosno većega obujma raspiljuju s manjim posmičnim brzinama, pri njihovoj obradi postižu se veći kapaciteti tračne pile i obrnuto. Utjecaj obujma trupca na tehnički kapacitet tračne pile veći je od utjecaja promjene posmične brzine.

Ukupno se vrijeme piljenja produljuje povećanjem promjera trupca zbog duljega vremena samoga piljenja uvjetovanoga većim brojem propiljaka (slika 9). Pri tome se smanjuje udio vremena manipulacije u ukupnom vremenu, a raste udio vremena čistoga piljenja i povećava se kapacitet stroja (slike 10 i 11).

Porastom udjela vremena manipulacije u ukupnom vremenu, a time i smanjenjem udjela vremena operacije piljenja, smanjuje se kapacitet tračne pile trupčare. Vrijeme trajanja operacije vožnje trupca na kolicima do lista pile i zauzimanje mjere moguće je skratiti uvježbavanjem operatera za upravljačkim pultom.

Možemo zaključiti da je analizom snimljenih podataka uočeno da na kapacitet tračne pile trupčare najznačajniji utjecaj ima obujam trupca čijim povećanjem kapacitet raste.

Stoga je nužno, ako se prati učinak operatera na tračnoj pili trupčari, u izračunu norme uzeti u obzir obujam ulaznih trupaca koji se obrađuju. Dakle, za radno mjesto operatera na tračnoj pili trupčari nije preporučljivo uzimati fiksnu normu, već je nužno normu vezati uz obujam ulaznih trupaca.

Ovo je istraživanje ograničenoga karaktera jer se odnosi na određenu dimenziju i kakvoću trupaca i ispiljenih piljenica. Usto način piljenja i obrada trupaca bila je izvedena na uobičajeni način kako se inače izvodi u pilani u kojoj je istraživanje provedeno. Stoga to treba imati na umu pri interpretaciji rezultata istraživanja.

Ključne riječi: tračna pila trupčara, kapacitet, pilana, piljenje, norme

Authors' address – *Adresa autorâ*:

Josip Ištvanić, PhD.
e-mail: istvanic@sumfak.hr
Department of Material Technologies
Prof. Ružica Beljo Lučić, PhD.
e-mail: beljo@sumfak.hr
Matija Jug, BSc.
e-mail: jug@sumfak.hr
Department of Process Techniques
Forestry Faculty of Zagreb University
Svetošimunska 25
HR–10000 Zagreb
CROATIA

Rajka Karan, BSc.
e-mail: rajka.karan@ka.t-com.hr
Sencon d.o.o.
Buzinska cesta 52
HR–10 000 Zagreb
CROATIA

Received (Primljeno): January 23, 2009
Accepted (Prihvaćeno): June 2, 2009