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Full Length Research Paper

The study for the strain of hardwood materials against machines and cutters in planning process

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In this study, during the planning of hardwood materials, the strain against horizontal (bottom) milling machines and cutter types is investigated. With this aim, 4 different hardwood materials, including eastern beech (*Fogus orientalis* L.), sessile oak (*Quercus borealis* L.), ashen (*Fraximus excelsior* L.) and locust (*Robinis pseudoacacia* L.) are used. In experimental contrivance prepared according to 4 types of wooden materials, 3 different engine revolutions numbers and 3 different drive forwarding speed, 180 experiments are done and the resultant strain is measured with ammeter. By using the experimental data; multiple linear regression analysis is done with the aim of predicting the strain according to material types, engine revolution number and drive forwarding speed, and for the situations which are not determined with the experiments, mathematical model equations are made up to calculate the strain. As a result, in the same experimental contrivances, the most strain is seen in the sessile oak and, respectively, locust, ashen and eastern beech follows this. In the planning process by keeping low revolution engine revolution number and drive forwarding speed, it is defined that current amount is decreased and the wooden material resists less to machines and cutters. It is determined that the results which are obtained by the results of the experiment and estimate models have very high correlation (R^2 = 0.92).

Key words: Wood material, planning, current, ampere (A), strain, modeling.

INTRODUCTION

Forest, one of our natural resources, is consumed fast as a result of the rise at usage. With this reason, besides producing new products, it is important to use efficiently available raw materials. Research studies are continued for using efficiently the products as much as the tree itself. Especially to study with lesser loss, new equipment, new staff and new processing methods are developed. Forest products are formed after various processes. It can say that planning is the first among forming methods. In the forming processes, various kinds of machines like milling machines, planning machines are used.

For processing hardwood material in high quality, it is necessary to know planning machines and cutters, to design these in an appropriate way and to use according to the technique. Therefore, it is essential to have basic knowledge about some parameters like wood material which will be processed, wood processing techniques, chip formation, cutting tool geometry, engine revolution number, cutting speed, forwarding speed, wood shavings depth, type and life span of cutter (Korkut et al., 1999; Ilhan et al., 1990). In processing wood materials, without decreasing product quality, to decline production inputs and cost processing parameters above is necessary to be optimum. The strain and cutting forces which occur in the process of planning have an important effect on product quality and especially on the cost (Mustafa, 2003). All the factors must be defined very well, especially in the first place, the strain which wood materials cause to machines and cutters in order to decrease energy waste without declining product quality of the machine in the process of planning (Hammond at al., 1969). In the study which is about the strain that wood materials show against the machines and cutters, a systematic model is developed for specific flowing tensile, it is indicated that there is no meaningful physical relations between geometric slipping tensile and strain measurements, that there is a weak relation between the measurements of geometric tensile and strain rate, and that there is a strong relation between material features

Table 1. Information about engine power of the milling machine.

Technical properties of engine				**Tip:CM112M-2**
3 Engine			Nc	127375
A	V	380	A	8,03
5,5	HP	4	Kw	2884d/d
120:8		CosPO,89		50 Hz
TP4 4-10, 41– B3				S1 Rot: N
TS 737- 3067				1 51

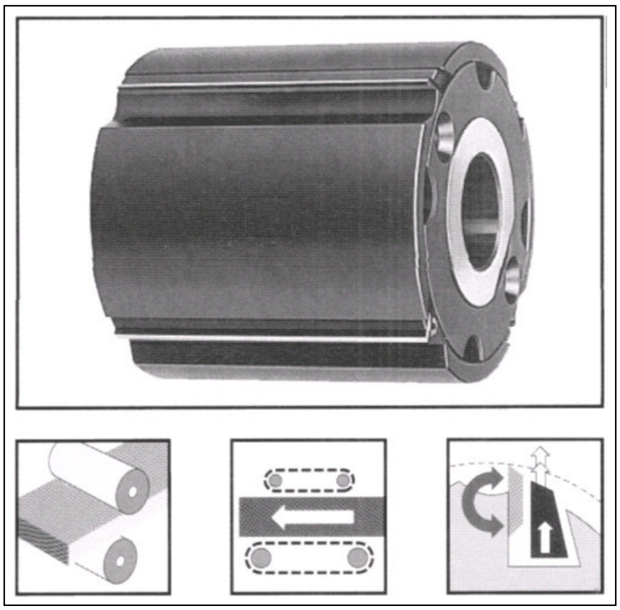

Figure 1. Fraises ball with razor blade.

and input variables like cutting speed, wood shavings, etc (Kurt, 2001).

It is defined that, in the process of planning, cutting forces which occur during lifting wood shavings, affect cutting performances and cost of unit part. While lifting wood shavings, teams which are used in the process of metals and metal alloy are pretty forced because of strain although, they are sharp enough. It is pointed out that in mechanics of lifting wood shavings, amendments are gained with the improved computer packet programs (Ansys, Franc2d) (Seker, 2000). Specific cutting energy which represents the energy required while lifting wood shavings is researched as an experiment and cutting forces are tried to be measured. It is pointed out that force components are directly proportional with progressing speed and that cutting forces increase when wood shavings depth increase. Also, it is stated that while cutting speed is going up, specific cutting energy decrease (Yardimoglu and Boyar, 1992). With this aim of measuring cutting forces on the counter of lathe, fraises and grinder, Dynamometer “strain meter type” which is created (Korkut, 1996). Hamid and Ali conduct a big part of their vertical cutting metal experiment for aluminum 2d4-T6 by using cemented carbide sets according to the variables like revolution number, processing speed and cutting depth. During the process of the first a few circles after the contact of team-work part, they test time and frequency analysis by recording temporary dynamic force attitude. In most of the experiments, according to cutting condition, they show that they reach balance situations of cutting and pushing forces in the levels of 1,5-2 circles (Hamid and Ali, 1995).

In this study, during the planning of hardwood materials, the strain against horizontal (below) milling machine and cutter types is examined. The strain showed by 4 types of wood materials, eastern beech, sessile oak, ashenens and locust which are selected as samples is tried to be defined with current values which engine absorbs. Strain values of horizontal milling machine and cutters are determined according to material type, engine revolution number and drive forwarding speed, which are variables.

MATERIALS AND METHODS

Materials

In the experiments, eastern beech (*Fogus orientalis* L.), sessile oak (*Quercus borealis* L.), ashenen (*Fraximus excelsior* L.) and locust (*Robinia pseudoacacia* L.) are used. In the planning of experimental samples, a horizontal milling machine with a drive is used, too. Ammeter is made use of measuring the current. The horizontal milling machine which is used has engine revolution number that can be adjusted at 2900, 6000 and 1000 revolution number, and can fix a drive. Information about engine power which belongs to he milling machine is showed at Table 1. The drive with 3 wheels can be adjusted to 4.08, 6.3 and 12.48 m/min forwarding speed. In the planning of the wood material, hard metal (HM) which has double faced 40° wedge angle and is resistant to rusting and is produced by pressed carbon steel on the aluminum fraises ball that is 85 mm calibers and 50 mm width. It is elaborated that cutters are new and whetted. Fraises ball and cutter sets are showed at Figure 1. The current intensity which passes through electric circuit during the planning of the wood material is measured with ammeter. The ammeters which are used are 8 and 12A devices that are aneroid, sensitive analogue indicator. Because the current passing through the receiver also passes through the ammeter, the device is connected in series one after another with the receiver (load or device). Wood materials are glued and the sample is kept to the width of 50 cm in order to give experimental samples to the machine with a drive easily and to make a sensitive planning with-

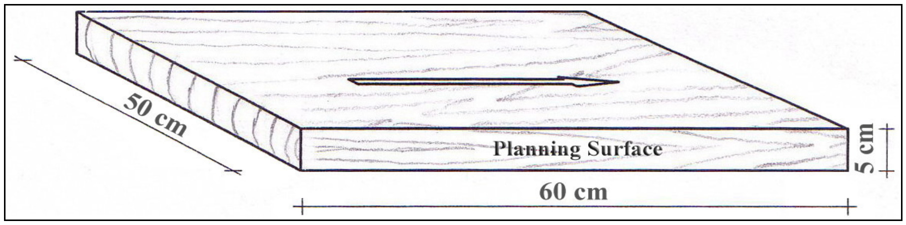

Figure 2. Experimental sample.

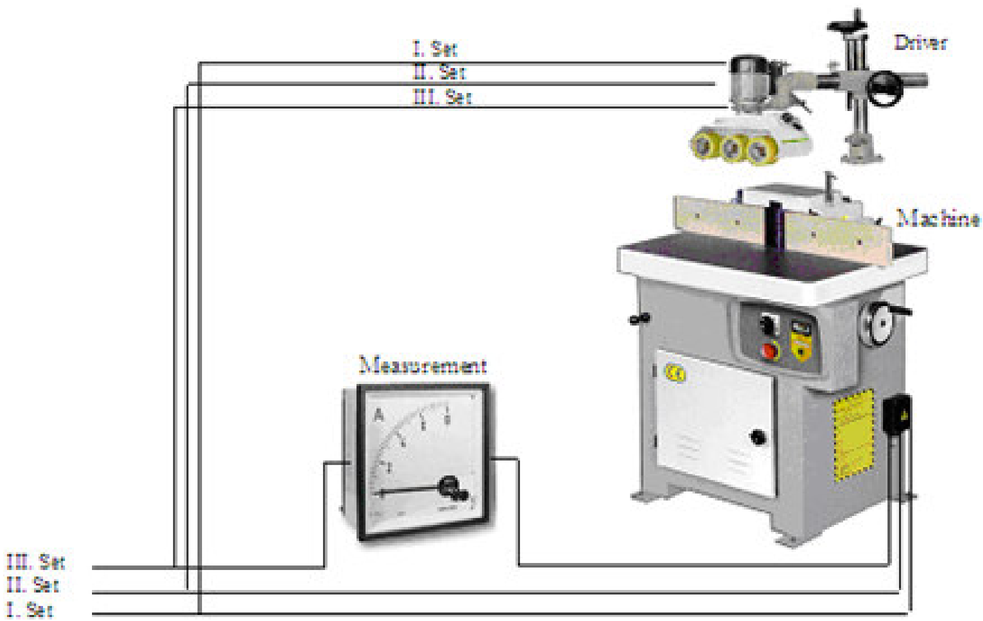

Figure 3. Experimental contrivance.

out vibrating. Samples are prepared as in the length of 60 cm and in the thickness of 50 cm (Figure 2).

Giving rough tolerance to the measurements of the wood materials which are prepared as in Figure 2, draft parts are prepared in enough amounts. The prepared draft parts are waited according to TS2471 principles until their weight becomes stable (12% humidity amount) in closed environment whose relative humidity is 65 ± 3% and heat is 20 ± 2℃ (TS, 1976). Dried draft parts are made ready for the experiment with its last measurements, and intensity of wood materials which are used in experiments is calculated.

Methods

While draft parts in about 12% humidity are worked by 2900, 6000 and 10000 rev/min, forwarding speed is adjusted with the drive and it is given to the machine in the forwarding speed of 4.08, 6.3 and 12.28 m/min. Only the current intensity which the engine of the machine absorbs is measured with ammeter. Because the current intensity which comes to the engine is the same at 3 phases, analogue ammeter is connected to one phase and experimental contrivance is prepared. When the machine is worked first and the cutters begin to plane the wood material, firstly ammeter with high indicator (12A) is used. When during forwarding the planed experimental samples, the engine acceleration and the value on the dial which is observed through ammeter become stable (when planning reaches to 500 mm), ammeter is ejected from the circuit with a key contrivance which is prepared before, and another 8A ammeter which can measure sensitively is used. Experimental contrivance is showed at Figure 3.

In order to prevent vibration of the ammeter, dielectric materials preventing vibration from the table where the measurement is done are used and are placed in a way that the device, dust and dirt resources do not affect. For reliability of the measurement value, every experimental sample is applied to planning 5 times. While determining resistance of machines and cutters in the process of planning of hardwood materials, 180 total (4x3x3x5) measurements from 5 ones of every group are done in order to determine the effects of material type, engine revolution number and drive forwarding speed, and then the available values are applied to statistical analysis. On the current values acquired from the experiment, multiple variance analysis is done to determine the effects of wood material, engine revolution number and drive forwarding speed. Duncan multiple comparison test is applied as to compare the dissimilarities among the groups. Also multiple linear regression analysis is done depending on engine revolution number and drive forwarding speed in every type of wood material, and for estimating of the current amount during planning, model equations are created.

Table 2. Explanatory statistics related to the effects of different hardwood materials on engine revolution number and drive forwarding speed.

Kinds of wood	Engine revolution speed (rev/min)	Number of sample	Drive forwarding speed.(m/min)					
			I. (4.30)		II. (6.30)		III. (12.48)	
			Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation
Sessile oak	2900	5	3.7900	0.1710	4.2820	0.0540	4.5140	0.0207
	6000	5	4.6000	0.0354	4.8140	0.0410	5.9120	0.2190
	10000	5	5.1000	0.0000	5.4500	0.0354	6.9200	0.2950
	Total	15	4.4967	0.5665	4.8487	0.4959	5.7820	1.0399
Locust	2900	5	3.7120	0.0415	4.2820	0.0205	4.8820	0.0205
	6000	5	4.1500	0.0354	4.6500	0.0354	5.6000	0.1225
	10000	5	5.0320	0.0409	5.1820	0.0205	7.0600	0.1140
	Total	15	4.2980	0.5694	4.7047	0.3832	5.8473	0.9423
Ashen	2900	5	3.5500	0.0354	4.1320	0.0890	4.3640	0.0410
	6000	5	4.0320	0.0205	4.4500	0.0000	5.5780	0.0179
	10000	5	4.7280	0.0179	5.3500	0.0354	5.8420	0.0427
	Total	15	4.1033	0.5011	4.6440	0.5364	5.2613	0.6670
Eastern beech	2900	5	3.4900	0.1342	3.8320	0.0205	4.8140	0.0207
	6000	5	3.9000	0.0000	4.1500	0.0000	4.8500	0.0354
	10000	5	4.3220	0.0179	4.7640	0.0207	5.6860	0.0546
	Total	15	3.9040	0.3590	4.2487	0.4007	5.1167	0.4186

STATISTICAL ANALYSIS OF EXPERIMENTAL RESULTS

Explanatory statistics related to the effects of different hardwood materials in the process of planning on engine revolution number and drive forwarding speed are given at Table 2.

On the current values acquired as a result of experimental studies, results of variance analysis related to wood material type, engine revolution number and drive forwarding speed are given at Table 3.

In the factors that are used for trial, wood material type, engine revolution number and drive forwarding speed show that during planning, the strain becomes important for $p \leq 0.05$ error possibilities. Among the dual interactions, wood material type – engine revolution number, wood material type – drive forwarding speed, engine revolution number – drive forwarding speed interaction becomes important with $p \leq 0.05$ tolerances statistically. The triple interaction wood material type – engine revolution number – drive forwarding speed, becomes important with $p \leq 0.05$ tolerance. The results of Duncan multiple comparison test which belongs to the triple interaction of wood material type – engine revolution number – drive forwarding speed are given at Table 4.

According to these results, it is pointed out that the lest compelling ones of machines and cutters are eastern beech (3.49A) and ashenen which are planed in the speed of 2900 rev/min engine revolution number and 4.08 m/min drive forwarding speed. It is seen that the most compelling one is locust whose engine speed is 10000 rev/min and drive forwarding speed is 12.48 m/min. Although, every wood material is planed with the same working features, each subjects the engine to different strain and causes the absorption of different electric current. This situation shows that there is a strong relation among wood material type, engine revolution number and drive forwarding speed (5).

The results of Duncan multiple comparison test belonging to the triple interaction of wood material type – engine revolution number – drive forwarding speed are showed in Figure 4. The results of Duncan multiple comparison test done in order to understand whether there is any differences on account of current values during planning according to wood material type, engine revolution numbers and forwarding speed are given at Table 5.

According to the results of Duncan multiple comparison test, it is pointed out that current values are different on meaningful level of $p \leq 0.05$ on account of wood material types. Accordingly, among wood material types, while the lest strain against machines and cutters is observed in eastern beech (4.42A), it is seen respectively that ashenen (4.66A), locust (4.95A) and sessile oak (5.04A) follow this. As it is understood from different current

Table 3. Results of variance analysis of current values related to wood material type, engine revolution number and drive forwarding speed.

Source	Type III sum of squares	Degree of freedom	Mean square	F	Significant (p ≤ 0.05)
Corrected model	126.441	35	3.613	529.299	0.000 *
Intercept	4097.716	1	4097.716	600373.586	0.000 *
Kind of wooden materials	10.667	3	3.556	520.947	0.000 *
Drive forwarding speed (m/min.)	53.102	2	26.551	3890.073	0.000 *
Engine revolution speed (rev/min)	52.158	2	26.079	3820.963	0.000 *
Kind of wooden materials* Drive forwarding speed	1.277	6	0.213	31.187	0.000 *
Kind of wooden materials* Engine revolution speed	3.088	6	0.515	75.401	0.000 *
Drive forwarding speed*Engine revolution speed	2.777	4	0.694	101.709	0.000 *
Kind of wooden materials *Drive forwarding speed*Engine revolution speed	3.373	12	0.281	41.182	0.000 *
Error	0.983	144	0.006825		
Total	4225.141	180			
Corrected total	127.424	179			

* It is meaningful according to 0.05.

values absorbed, every wood material causes different strain and absorbs different current. It can be said that this feature sources from the effect of different physical and mechanic features of each material. According to the results of Duncan multiple comparison test, it is understood that current values on the account of engine revolution number is different on the level of $p \leq 0.05$ meaningfulness. Among engine revolution numbers, the lest strain is observed in 2900 rev/min absorbing 4.14A, and respectively, 6000 rev/min absorbing 4.72 A and 10000 rev/min absorbing 5.45A follow this. From these results, it can be said that when revolution number is increased, the resistance of wood material against planning is increased, too. It is thought that this situation sources from work amount which hits every jog in unit time (Seker, 2000).

According to the results of Duncan multiple comparison test, it is seen that current values are different on the level of $p \leq 0.05$ meaningfulness on account of drive forwarding speed. Accordingly, the lest strain, respective-ly, occurs in 4.08 m/min absorbing 4.20A and 6.30 m/min absorbing 4.61A and 12.48 m/min absorbing 5.50A drive forwarding speed. Eventually, it appears that when drive forwarding speed is increased, the resistance of the material against planning increases, too and for this, the machine requires more current. It is thought that this situation comes from work amount which hits every jog in unit time is increased when drive forwarding speed increases although engine power is stable during planning (Yardimoglu and Boyar, 1992). Fiber tearing which is seen on facets of planed wood materials is seen as an indicator of this situation. For relating to current values absorbed by wood materials which are used in experiments, specific weight, Brinell hardness and pressure values parallel to fibers are determined. The accuracy rates of the determined values are given at Table 6 with absorbed current values by comparing to the literature (Ors, 2001; Bektas and Guler, 1999; Berkel, 1970).

Each of the wood materials used in experiments shows differences in ratio on account of absorbed current according to (H) the values of specific weight (r^{12}) and Brinell hardness. This situation shows that every wood material will have different strain against machines and cutters in the face of the factors which affect the planning. When engine revolution number is increased during the planning, more current is required to obtain rotor pin connected to the engine and cutter movement. When engine revolution number is increased, chip number cut in unit time is increased and before the engine looses its own revolution (speed), it tries to continue its movement because the power which is spent for every cut chip decreases. Necessary cutting power must be the cutting inertia power connected to the cutting inertia resistance which can defeat the cutting power with the highest resistance of wood material. It can be said that for speed and factors connected to this affect directly the power (http, 2006). Also, the cutters in the planning process do not give an opportunity to be cracked and broken because of their wedge angles (40°) and it is thought that this does not increase the strain of the engine with a proper cutting work by shocking because of their high speed. When it

Table 4. The results of Duncan multiple comparison test which belongs to the triple interaction of wood material.

Kind of wooden materials	Engine revolution speed (rev/min)	Drive forwarding speed (m/min.)	Groups (A)																						
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Sessile oak	2900	4.08		3.8	3.8																				
		6.30							4.3																
		12.48									4.5	4.5													
	6000	4.08										4.6	4.6												
		6.30													4.8	4.8	4.8								
		12.48																					5.9		
	10000	4.08																5.1	5.1						
		6.30																		5. 5					
		12.48																						6.9	
Locust	2900	4.08		3.7																					
		6.30							4.3																
		12.48															5.0								
	6000	4.08						4.2																	
		6.30											4.6	4.6											
		12.48																			5.6				
	10000	4.08																5.0							
		6.30																	5.2						
		12.48																							7.1
Ashen	2900	4.08	3.6																						
		6.30					4.1	4.1																	
		12.48							4.4	4.4															
	6000	4.08					4.0																		
		6.30								4.5	4.5														
		12.48																			5.6				
	10000	4.08												4.7	4.7										
		6.30																		5.4					
		12.48																					5.8		

Table 4. Contd.

Eastern beech	2900	4.08	3.5									
		6.30		3.8	3.8							
		12.48							4.8	4.8	4.8	
	6000	4.08			3.9							
		6.30				4.2						
		12.48							4.9	4.9		
	10000	4.08					4.3					
		6.30						4.8	4.8			
		12.48										5.7

Type – engine revolution number – drive forwarding speed.

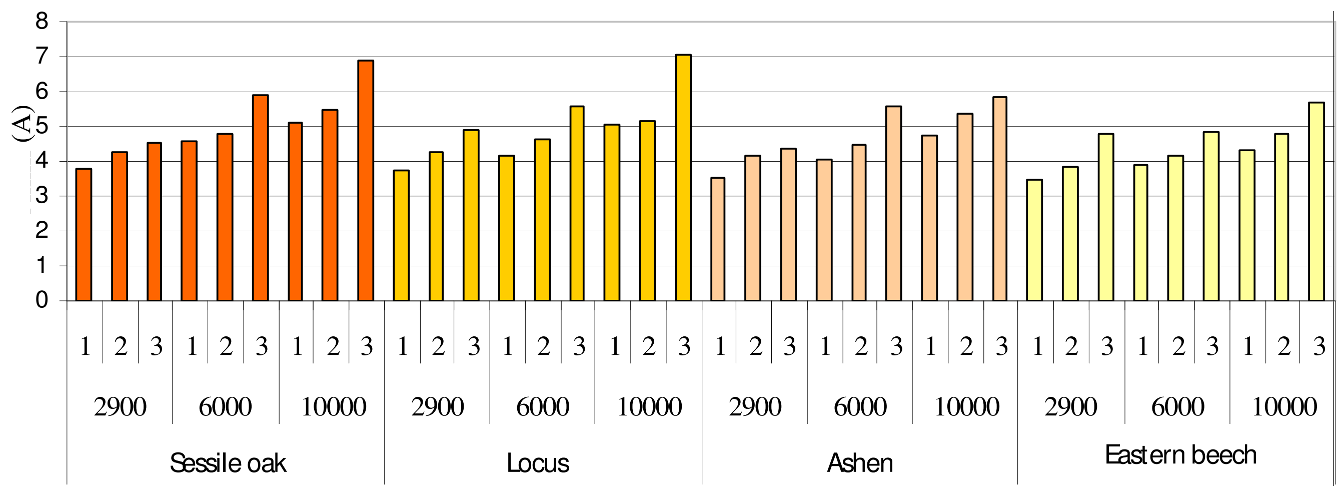

Figure 4. The graphical results of Duncan multiple comparison test belonging to the triple interaction of wood material type – engine revolution number - drive forwarding speed.

comes to the cutters with low speed, it is estimated that it does not throw (scatter) fast the wood shavings which it cuts from wood material during planning and causes the tearing of the fibers by being stuck among wood materials fibers which require to be planed. For this reason, it is thought that the engine causes absorbing more current against tearing and a clear-cut facet planning cannot be done. Eventually, it can be expressed that more power is spent in planning which is done with high engine revolution, but this sources from its own rotor pin and the power which is spent for the cutters

Table 5. The results of Duncan multiple comparison test among wood material types.

Factors		N	Different groups ($p \leq 0.05$) A			
			1	2	3	4
Kind of wooden materials	Eastern beech	45	4.4231			
	Ashen	45		4.6696		
	Locust	45			4.9500	
	Sessile oak	45				5.0424
Engine revolution speed (rev/min)	2900	60	4.1370			
	6000	60		4.7238		
	10000	60			5.4530	
Drive forwarding speed (m/min.)	4.08	60	4.2005			
	6.30	60		4.6115		
	12.48	60			5.5018	

Table 6. The relation among the current values which wood materials absorbs and specific weight, brinell hardness and resistance of pressure values parallel to fibers.

Kind of wooden material	Specific weight r^{12} (gr/cm^3)	Brinell hardness value ($H^{||}$) (Kg/mm^2)	Resistance of pressure values parallel to fibers (Kg/cm^2)	Amount of spent current ($p \leq 0.05$) A
Eastern beech	0.66	4.81 - 6.90	644	4.4231
Ashen	0.69	6.50	520	4.6696
Locust	0.76	7.82	730	4.9500
Sessile oak	0.69	6.60	650	5.0424

Table 7. Multiple linear regression analysis by considering engine revolution number and drive forwarding speed for every wood type.

Kind of wood	Model equation (Y = a+bX +cZ)	Determination coefficient (R^2)
Sessile oak	$y = 2.450+0.0002269x_1+0.153x_2$	0.903
Locust	$y = 2.233+0.0002080x_1+0.185x_2$	0.933
Ashen	$y = 2.544+0.0001806x_1*M+0.130x_2$	0.921
Eastern beech	$y = 2.540+0.0001253x_1+0.144x_2$	0.970

connected to this pin, besides less power is necessary for planning. It can be said that engine requires high current amount in order to obtain its own movement in high revolution.

By considering engine revolution number and drive forwarding speed for every wood material, multiple linear regression analysis is done. R^2 values acquired as a result of the regression analysis and model equations are given at Table 7. In the model equation, y = current, x_1 = engine revolution number, x_2 = drive forwarding speed and a, b, c represent for the coefficients acquired from regression analysis.

According to the regression model equations, it appears that current values which are absorbed engine revolution number and drive forwarding speed can be estimated before with an error possibility between 1.6 and 4.3% (Figure 5).

With the regression model equation which is found on the account of engine revolution number and drive forwarding speed, current values are calculated and are compared to real current values. The fallibilities while estimating real current values of current values calculated with regression technique are determined. According to this, current values acquired with regression technique are estimated with the fallibility of 4.3% for sessile oak, 3.75% for locust, 1.6% for eastern beech and 3.6% for ashenen.

RESULTS AND RECOMMENDATIONS

In this study, strain which is resisted by the group of

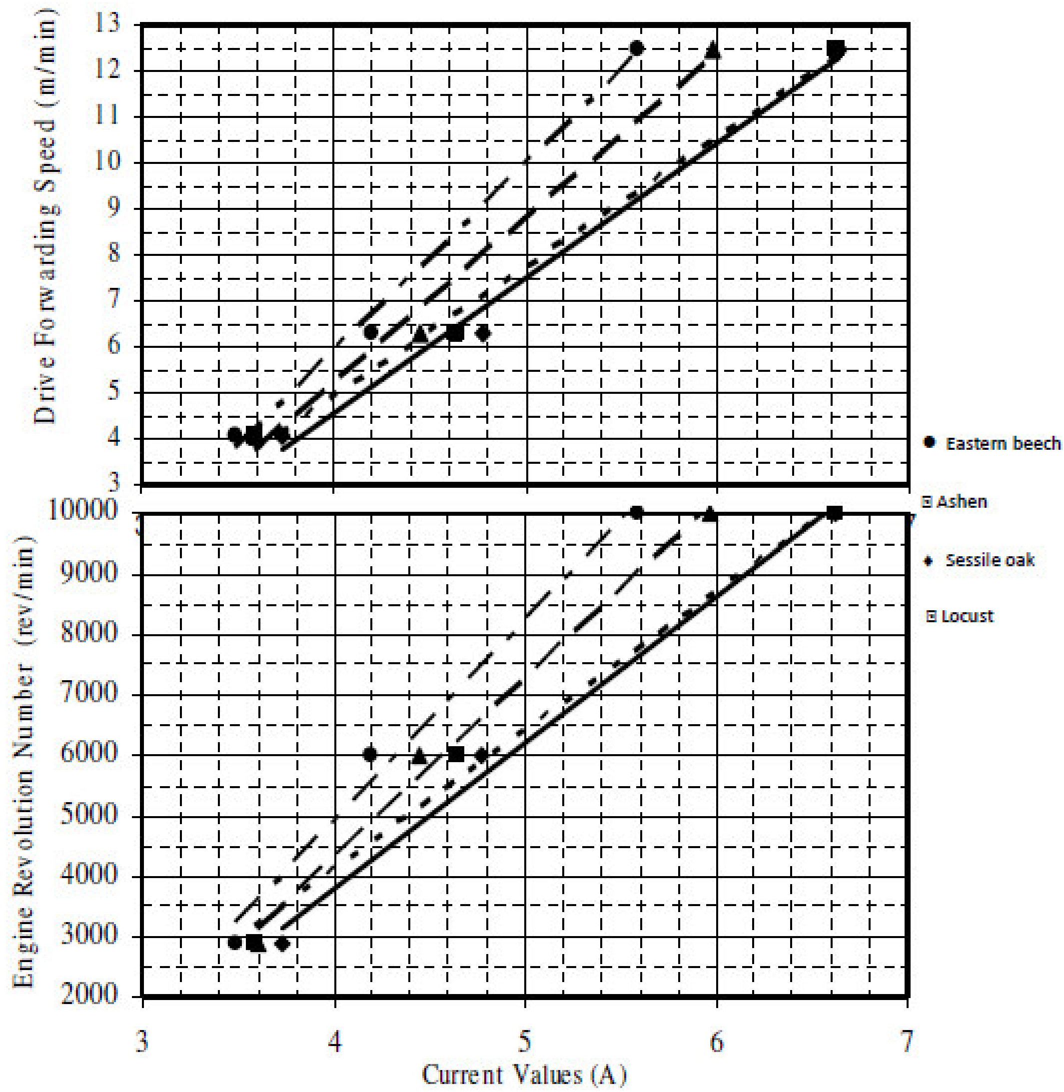

Figure 5. Relationship between current values, engine revolution number and drive forwarding speed.

hardwood material, including eastern beech, sessile oak, ashenen and locust, during planning to machines (engine) and cutters, on the account of current values which engine absorbs is tried to be determined. Accordingly, for the same forwarding speed and different engine revolution numbers:

At the forwarding speed of 4.3 m/min

It is seen that in an engine working with 2900 rev /min, the lest absorbed current amount is in eastern beech with 3.49A and the most absorbed current amount is in sessile oak with 3.79A. In an engine working with 6000 rev/min, the least absorbed current amount is in eastern beech with 3.90A and the most absorbed current amount is in sessile oak with 4.60A.

In an engine working with 10000 rev/min, the least absorbed current amount is in eastern beech with 4.32A and the most absorbed current amount is in the sessile oak with 5.10A. Accordingly, among the hardwood materials that process which are subjected to different revolution number at the same forwarding speed, eastern beech is defined as the least compelling one of machines and cutters and sessile oak becomes the most compelling one.

At the forwarding speed of 6.30 m/min

In an engine working with 2900 rev/min, the least absorbed current amount is in eastern beech with 3.83A and the most absorbed current amount is in sessile oak and locust with 4.28A. In an engine working with 6000 rev/min, the least absorbed current amount is in eastern beech with 4.15A and the most absorbed current amount is in sessile oak with 4.81A. In an engine working with 10000 rev/min, the least absorbed current amount is in eastern beech with 4.76A and the most absorbed current amount is in sessile oak with 5.45A.

At the forwarding speed of 12.48 m/min

In an engine working with 2900 rev/min, the least absorbed current amount is in ashenen with 4.36A and the most absorbed current amount is in locust with 4.88A. In an engine working with 6000 rev/min, the least absorbed current amount is in eastern beech with 4.85A and the most absorbed current amount is in sessile oak with 5.91A. In an engine working with 10000 rev/min, the least absorbed current amount is in eastern beech with 5.68A and the most absorbed current amount is in sessile oak with 6.92A.

Among the hardwood materials applied the same processes, it is determined that the least compelling one of machines and cutters is, respectively, eastern beech, ashenen, locust and sessile oak. This order must be considered in order to decrease electricity waste and minimize abrasion of machine/engine. It is understood that when engine revolution number is increased, more power is spent for cutters movement connected to the pin and its own rotor pin of the machine, and naturally less power is required for planning. It is crucial for engines not to be used over high revolutions in order not to increase electricity cost by absorbing too much and not to rust in vain.

It is seen that when drive, forwarding speed is increased, resistant of the material to planning increase as well, and for this reason, machine requires more current. In order to decrease the current amount which is spent, engine revolution number and drive forwarding speed must be selected according to wood material type and facet quality which is wanted.

Each of the wood materials which are used in experiments show differences ratio on the account of absorbed current. While eastern beech is the wood type which absorbs the least current, sessile oak is the wood type which absorbs the current the most. Main reason of this situation can be the factors like specific weight, Brinell hardness, texture structure of the wood, etc. The specific weight of eastern beech is 0.66 g/cm^3 and Brinell hardness value of it is between 4.81 and 6.9. The specific weight of sessile oak is 0.69 g/cm^3 and Brinell hardness value of it is 6.6. As it is inferred from these data, it can be said that current amount which wood materials absorb changes according to their Brinell hardness values be side their specific weight.

Especially in large-sale managements churning out, it is thought to save up from electricity, cost of machine, engine and cutter abrasion when wood materials which show advantage according to different absorbed current values are preferred in the light of available results. According to the results of regression analysis, current values which are estimated on the account of the values of engine revolution number and drive forwarding speed can be estimated with the determination coefficients which are R^2 = 0.903 for sessile oak, R^2 = 0.933 for locust, R^2 = 0.921 for ashenen and R^2 = 0.970 for eastern beech.

Fallibilities of current values calculated with regression analysis when estimating real current values are determined. Accordingly, current values acquired with regression technique are estimated with the fallibility of 4.3% in sessile oak, 3.75% in locust, 1.6% in eastern beech and 3.6% in ashenen.

DISCUSSION

According to the research results, it has been observed that the least compulsive hard wood which has been subjected to the same processes is beech followed by ordinary ash, acacia and oak respectively. It has been thought that if these hardwoods used in the tests have been preferred by considering this grading order in the industry, the advantages can be gained in terms of electrical consumption and the abrasion on machinery / motor.

It can be expressed that if the revolution number of motor is increased, more power is spent because of the resistance of the wood to planning however, this is resulted from the power needed to move the rotor axle and the cutters attached to the axle and in addition to this, and the less power is required to planning. This case is parallel to the literature knowledge (Yardimoglu and Boyar, 1992). It can be said that a serious amount of current is needed for motor movement in high revolution rather than the amount of current consumption for planning of hardwood. It is very important that engines are not used in high revs to avoid increasing electricity expenditure by excessive current consumption.

It is eventually appeared that the resistance of the wooden material to planning has increased when the feed speed has been increased and the machine needs more current for this. To prevent this, it has been advised to work in synchronized conditions depending on feed speed and preferred wooden material and the desired surface quality and also planning in optimum feed speeds which do not cause excessive compulsions. This situation has been showing that there is a strong correlation between the type of wooden material and driver revolution number and is in conformity with the literature (Kurt, 2001).

The each wood type used in the tests has been showing proportional diversities in density (MC12), Brinell hardness values ($H^{||}$), and drawing currents. This aspect is proved that each wood type is going to have different compulsions against the machine and cutters according to the factors which effect planning. It has been concluded that the current values can be predicted in advance with an error portion of 3% for each wooden material type determination factor depending on the number of revolution and feed speed in accordance with realized regression model equations. In the light of these results, very important improvements can be achieved in chipping lifting mechanics by using computer technology and it can give advantages to the economy which also conforms to the literature (Seker, 2000).

In the knowledge of these results, especially in mass-production enterprises, important amounts of provident of electricity, machine motor and cutter attrition can be achieved by preferring the advantageous wooden materials in terms of their different current drawing values.

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