ABOUT THE PLANING CROSS LAMINATED SOLID WOOD

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Abstract
This work paper is about the measurement of cross cutting by milling laminated solid wood witch requires some drilling conditions. The scientific work has treated different aspects of the milling process. This values characterizing the values of the dynamic parameters. The specific cutting work represents a main factor to determining the values of power and cutting forces in milling. Also it characterizes the specific energy consumption for cutting.

Key words: Wood Milling, splintering, Cutting Power.

INTRODUCTION

Milling wood has the highest weight in the whole cutting operation. Further studies and research are extremely numerous. Studies and scientific work have treated different aspects of timber milling and cutting regimes and the construction and milling exploitations.

MATERIALS AND METHODS

For cutting power measurement using a power meter recorder (FLUKE 1653) mounted in the electrical circuit of the main engine of the milling machine (Figure 1). This wattmeter allows the measurement of cutting power with measurement accuracy of ±5 %. Each cutting value power represents the arithmetic mean value of five measurements performed on standard pieces in identical milling condition.

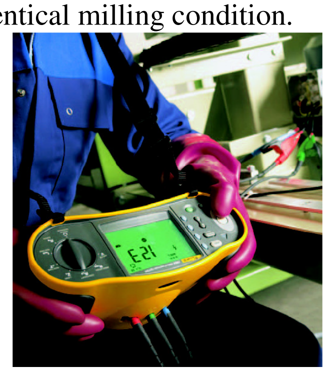

Fig. 1. Wattmeter recorder (FLUKE 1653)

Experiments were performed on a manual milling machine (FELDER PROFIL 40) with main features:

- Spindle speed n = 3000, 4500, 6000, 9000 rot/min
- Beating radial spindle mounting area mills $b_r \leq 0{,}004$ mm
- Electric motor power 2.8 kW spindle drive

Fig. 2. Manual milling machine

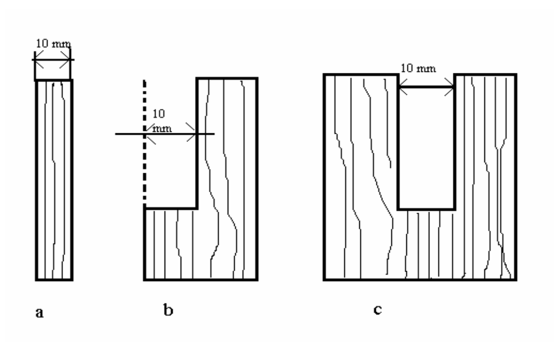

Fig. 3. Types of Milling

We used milling and head milling cutters manufactured and maintained by plant Codlea About ASCO TOOLS SA. The cutters used in experiments with the following characteristics:

- 240 mm diameter
- 30 mm bore
- Blade width b = 10 mm
- edged carbide teeth with 20 K
- number of teeth z = 4
- angles α = 15 °, β = 55 °, γ = 20 °
- sharp and measured at ASCO TOOLS SA

- radius of rounding of cutting edges $\rho \leq 0{,}005$ mm

To be able to study and have used the following:

- cross-cutting advances in tooth u_z = 0,1 mm; 0,2 mm; 0,4 mm; 0,6 mm; 0,8 mm; 1,0 mm; 1,2 mm; 1,6 mm
- h milling and the following heights: 1 mm; 5 mm; 10 mm; 15 mm; 20 mm; 25 mm; 30 mm; 35 mm; 40 mm; 45 mm; 50 mm.

RESULTS AND DISCUSSION

The first objective was to study experimentally and the dependence of the dynamic parameters of the cutting tool and the milling system of cross-tree wood. Thus the dependence of power consumption and the advance per tooth, depending on the depth of cut for the three types of milling (open, semi, closed) for sharp-edged.

Based on the values are determined:
Cutting K resistivity;
Average cutting force F_m;
Average and maximum cutting force per tooth F_{dm}, F_{dmax};

In table 1 is presented the cutting power P (kW):

- milling cross open / semi / closed-fir (F.D.= milling cross open, F.S.D.= milling cross semi, F.I.= milling cross closed-fir) wood with U = 8 – 10%,
- cutter diameter D = 240 mm,
- cutter speed n = 4500 rot/min
- number of teeth is z = 4,
- teeth with sharp-edged of K = 20 ($\rho \leq 0.005$mm),
- milling width b = 10 mm

Table 1

The cutting power in milling cross open / closed-fir wood process

Milling height		Advance per tooth in mm/ tooth, feed rate u in m/min							
h		0,1	0,2	0,4	0,6	0,8	1,0	1,2	1,6
		1,8	3,6	7,2	10,8	14,4	18	21,6	28,8
1	F.D.	0,03	0,03	0,035	0,038	0,04	0,045	0,047	0,057
	F.S.D.	0,03	0,03	0,035	0,038	0,04	0,045	0,047	0,057
	F.I.	0,03	0,03	0,035	0,038	0,04	0,045	0,047	0,057
5	F.D.	0,07	0,08	0,095	0,11	0,13	0,15	0,16	0,19
	F.S.D.	0,07	0,08	0,1	0,11	0,13	0,16	0,17	0,2
	F.I.	0,07	0,08	0,1	0,12	0,13	0,17	0,18	0,21
10	F.D.	0,1	0,11	0,14	0,17	0,21	0,25	0,29	0,34
	F.S.D.	0,1	0,11	0,14	0,18	0,22	0,25	0,3	0,36
	F.I.	0,1	0,11	0,15	0,2	0,24	0,27	0,32	0,38
15	F.D.	0,13	0,13	0,18	0,22	0,27	0,315	0,37	0,43
	F.S.D.	0,13	0,14	0,19	0,23	0,28	0,34	0,4	0,47
	F.I.	0,13	0,15	0,2	0,24	0,29	0,36	0,43	0,51
20	F.D.	0,14	0,16	0,2	0,25	0,31	0,36	0,43	0,48
	F.S.D.	0,14	0,16	0,2	0,26	0,34	0,39	0,45	0,53
	F.I.	0,15	0,17	0,24	0,29	0,36	0,42	0,48	0,59
25	F.D.	0,17	0,19	0,25	0,29	0,36	0,41	0,49	0,54
	F.S.D.	0,17	0,2	0,27	0,31	0,39	0,45	0,5	0,6
	F.I.	0,18	0,21	0,28	0,34	0,42	0,49	0,58	0,66
30	F.D.	0,19	0,22	0,29	0,35	0,43	0,5	0,58	0,65
	F.S.D.	0,19	0,23	0,31	0,38	0,47	0,55	0,64	0,72
	F.I.	0,2	0,24	0,32	0,43	0,5	0,6	0,68	0,79
35	F.D.	0,21	0,23	0,32	0,38	0,46	0,54	0,6	0,67
	F.S.D.	0,21	0,24	0,34	0,41	0,50	0,58	0,67	0,72
	F.I.	0,22	0,25	0,34	0,44	0,55	0,63	0,72	0,84
40	F.D.	0,23	0,24	0,34	0,43	0,53	0,6	0,68	0,77
	F.S.D.	0,24	0,25	0,36	0,47	0,57	0,66	0,75	0,86
	F.I.	0,24	0,26	0,38	0,5	0,62	0,72	0,85	0,96
45	F.D.	0,25	0,27	0,35	0,44	0,54	0,61	0,68	0,76
	F.S.D.	0,26	0,28	0,40	0,49	0,60	0,68	0,78	0,87
	F.I.	0,27	0,30	0,42	0,54	0,67	0,78	0,92	1,08
50	F.D.	0,28	0,30	0,39	0,50	0,60	0,68	0,78	0,88
	F.S.D.	0,29	0,31	0,42	0,54	0,66	0,75	0,85	0,96
	F.I.	0,30	0,33	0,45	0,58	0,72	0,83	0,99	1,2

In table 2 is presented the cutting power P (kW):

- Milling cross open / closed-fir wood with U = 8 – 10%,
- cutter diameter D = 240 mm,
- cutter speed n = 4500 rot/min,
- number of teeth z = 4,
- teeth with sharp-edged of K = 20 ($\rho \leq 0.005$mm),
- milling width b = 10 mm,
- the amount of material milled (milled length) L1 = 1 m, L2 = 200 m, L3 = 400 m, L4 = 600 m
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Table 2

The cutting power in milling cross open / closed-fir wood process in the amount of material

Milling height h / Milled length l		Advance per tooth in mm, feed rate u in m/min				
		$\frac{0,1}{1,8}$	$\frac{0,2}{3,6}$	$\frac{0,4}{7,2}$	$\frac{0,8}{14,4}$	$\frac{1,2}{21,6}$
1	L1 = 200	0,024/0,024	0,0375/0,037	0,04/0,04	0,05/0,05	0,055/0,055
	L2 = 400	0,027/0,027	0,04/0,04	0,046/0,046	0,055/0,055	0,06/0,06
	L3 = 600	0,029/0,029	0,043/0,043	0,05/0,05	0,06/0,06	0,065/0,065
10	L1 = 200	0,125/0,125	0,14/0,15	0,17/0,18	0,26/0,26	0,30/0,32
	L2 = 400	0,135/0,135	0,15/0,16	0,18/0,2	0,29/0,31	0,33/0,35
	L3 = 600	0,145/0,145	0,16/0,17	0,2/0,21	0,31/0,34	0,35/0,38
20	L1 = 200	0,175/0,19	0,2/0,21	0,26/0,29	0,37/0,43	0,54/0,6
	L2 = 400	0,19/0,21	0,22/0,23	0,29/0,31	0,4/0,47	0,57/0,63
	L3 = 600	0,21/0,22	0,23/0,25	0,31/0,33	0,44/0,5	0,61/0,65
30	L1 = 200	0,24/0,25	0,275/0,3	0,35/0,38	0,51/0,60	0,65/0,78
	L2 = 400	0,26/0,27	0,3/0,32	0,38/0,42	0,56/0,65	0,70/0,85
	L3 = 600	0,28/0,29	0,32/0,34	0,41/0,45	0,6/0,7	0,77/0,91
40	L1 = 200	0,29/0,3	0,3/0,32	0,41/0,46	0,64/0,74	0,74/0,96
	L2 = 400	0,31/0,32	0,32/0,35	0,44/0,49	0,69/0,81	0,81/1,05
	L3 = 600	0,33/0,35	0,35/0,38	0,48/0,53	0,74/0,87	0,87/1,12
50	L1 = 200	0,35/0,375	0,35/0,41	0,47/0,54	0,72/0,87	0,87/1,2
	L2 = 400	0,365/0,4	0,41/0,45	0,51/0,59	0,78/0,94	0,94/1,29
	L3 = 600	0,42/0,435	0,43/0,48	0,55/0,63	0,84/1,01	1,01/1,38

The knowing power cut resulting from the above tables we calculate the specific mechanical work cutting formula is denoted by K:

$$K = \frac{6 \times 10^4 \times P}{b \times h \times u}$$

Where:

h = Milling height
b = Milling width

In table 3 is presented the work of cutting specific K, in N*m/cm³ (specific cutting resistance K, in N/mm²):

- Milling cross open / semi / closed-fir (F.D.= milling cross open, F.S.D.= milling cross semi, F.I.= milling cross closed-fir) wood with u = 8 – 10 %
- teeth with sharp-edged of K = 20
- cutter diameter D = 240 mm
- number of teeth z = 4
- cutter speed n = 4500 rot/min

Table 3

The specific cutting resistance in cross open / semi / closed-fir case

Milling height		Advance per tooth in mm/ tooth, feed rate u in m/min							
		0,1 / 1,8	0,2 / 3,6	0,4 / 7,2	0,6 / 10,8	0,8 / 14,4	1,0 / 18	1,2 / 21,6	1,6 / 28,8
1	F.D.	100,00	50,00	29,17	21,11	16,67	15,00	13,06	11,87
	F.S.D.	100,00	50,00	29,17	21,11	16,67	15,00	13,06	11,87
	F.I.	100,00	50,00	29,17	21,11	16,67	15,00	13,06	11,87
5	F.D.	46,67	26,67	15,83	12,22	10,83	10,00	8,89	7,90
	F.S.D.	46,67	26,67	16,67	12,22	10,83	10,67	10,00	8,3
	F.I.	46,67	26,67	16,67	13,33	10,83	10,67	9,44	8,75
10	F.D.	33,33	18,33	11,67	10,00	9,17	8,00	6,94	7,09
	F.S.D.	33,33	18,33	11,67	11,11	9,58	8,33	7,22	7,50
	F.I.	33,33	20,00	12,50	11,11	10,00	9,00	8,06	7,91
15	F.D.	28,89	16,67	10,00	8,15	7,50	6,89	6,48	5,97
	F.S.D.	28,89	16,67	10,56	8,52	7,76	7,56	7,04	6,52
	F.I.	28,89	15,56	11,11	8,89	8,06	8,00	7,41	7,08
20	F.D.	23,33	13,33	9,17	6,94	6,46	6,00	5,97	5,00
	F.S.D.	23,33	13,33	9,58	7,32	7,08	6,50	6,53	5,52
	F.I.	25,00	14,17	10,00	8,06	7,50	7,00	7,08	6,14
25	F.D.	22,67	12,67	8,33	6,22	6,00	5,47	5,00	4,50
	F.S.D.	22,67	13,33	9,00	6,89	6,50	6,00	5,56	5,00
	F.I.	24,00	14,00	9,33	7,56	7,00	6,53	6,00	5,50
30	F.D.	21,11	12,22	8,06	6,48	5,97	5,56	5,00	4,51
	F.S.D.	21,11	12,78	8,61	7,04	6,53	6,11	5,46	5,00
	F.I.	22,22	13,33	8,89	7,96	6,94	6,67	6,02	5,48
35	F.D.	20,00	10,95	7,62	6,03	5,48	4,76	4,52	3,99
	F.S.D.	20,00	11,43	8,10	6,51	5,95	5,52	4,84	4,28
	F.I.	20,95	11,90	8,57	5,58	6,55	6,00	5,16	5,10
40	F.D.	19,17	10,00	7,08	5,97	5,52	5,00	4,31	4,01
	F.S.D.	20,00	10,42	7,50	6,53	5,94	5,50	4,72	4,48
	F.I.	20,00	10,83	7,92	6,94	6,46	6,00	5,56	4,98
45	F.D.	18,52	10,00	7,04	5,43	5,00	4,52	4,01	3,51
	F.S.D.	19,26	10,83	7,41	6,05	5,56	5,04	4,51	4,03
	F.I.	20,00	11,11	8,33	7,04	6,03	5,56	5,00	5,30
50	F.D.	18,67	10,00	6,50	5,56	5,00	4,53	4,00	3,66
	F.S.D.	19,33	10,33	7,00	6,00	5,50	5,00	4,53	4,00
	F.I.	20,00	11,00	7,50	7,00	6,00	5,53	5,50	5,00

In table 4 is presented the work of cutting specific K, in N*m/cm³ (specific cutting resistance K, in N/mm²):

- Milling cross open / semi / closed-fir (F.D.= milling cross open, F.S.D.= milling cross semi, F.I.= milling cross closed-fir) wood with u = 8 – 10 %
- teeth with sharp-edged of K = 20
- cutter diameter D = 240 mm
- number of teeth z = 4
- cutter speed n = 4500 rot/min
- the amount of material milled L1 = 200m, L2 = 400 m, L3 = 600m

Table 4

The specific cutting resistance in the amount of material milled case

Milling height h		Advance per tooth in mm, feed rate u in m/min 0,1 / 1,8	0,2 / 3,6	0,4 / 7,2	0,8 / 14,4	1,2 / 21,6
1	L1 = 200	80-80	62,5-62,5	33,3-33,3	20,8-20,8	15,3-15,3
	L2 = 400	90-90	66,6-66,6	38,3-38,3	22,9-22,9	16,6-16,6
	L3 = 600	96,6-96,6	71,6-71,6	41,6-41,6	25-25	18,1-18,1
10	L1 = 200	41,6-41,6	23,3-25	14,2-15	10,8-10,8	8,3-8,9
	L2 = 400	45-45	25-26,6	15-16,6	12,1-12,9	9,2-9,7
	L3 = 600	48,3-48,3	26,6-28,3	16,6-17,5	12,9-14,2	9,7-10,5
20	L1 = 200	29,2-31,6	16,6-17,5	10,8-12,1	7,7-8,9	7,5-8,3
	L2 = 400	31,6-33,3	18,3-19,2	12,1-12,9	8,3-9,8	7,9-8,8
	L3 = 600	35-36,6	19,2-20,8	12,9-13,8	9,2-10,4	8,5-9
30	L1 = 200	26,6-27,8	15,3-16,6	9,7-10,6	7,1-8,3	6-7,2
	L2 = 400	28,9-30	16,6-17,8	10,6-11,6	7,8-9	6,5-7,9
	L3 = 600	31,3-32,2	17,8-18,9	11,4-12,5	8,3-9,7	7,1-8,4
40	L1 = 200	24,2-25	12,5-13,3	8,5-9,6	6,7-7,7	5,1-6,6
	L2 = 400	25,8-26,8	13,3-14,6	9,2-10,2	7,2-8,4	5,6-7,3
	L3 = 600	27,5-29,2	14,6-15,8	10-10,4	7,7-9,1	6-7,8
50	L1 = 200	23,2-25	11,6-13,7	7,8-9	6-7,3	4,8-6,7
	L2 = 400	24,3-26,6	13,7-15	8,5-9,8	6,5-7,8	5,2-7,2
	L3 = 600	26.5-27.5	14,3-16	9,2-10,5	7-8,4	5,6-7,6

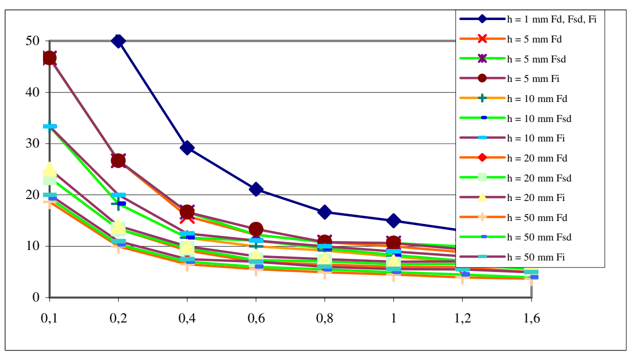

Fig. 4. The graphic of specific cutting advance depending on the tooth

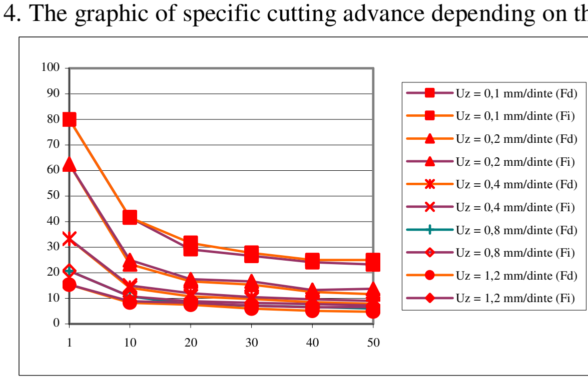

Fig. 5. The graphic of specific cutting depths is depending on the milling length (200 m)

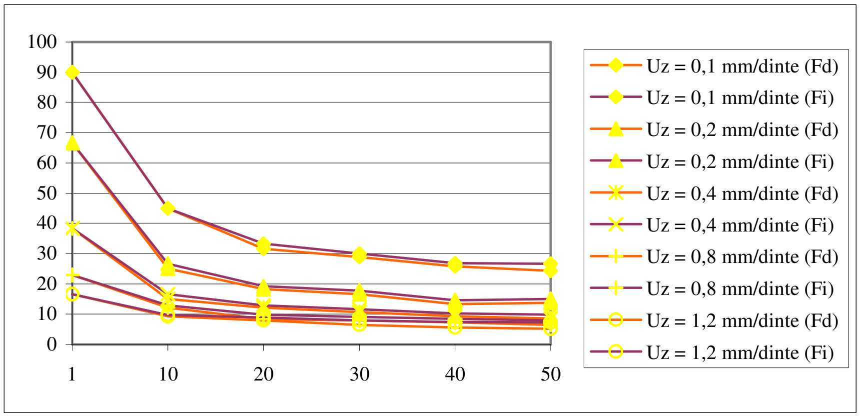

Fig. 6. The graphic of specific cutting depths is depending on the milling length (400 m)

CONCLUSIONS

The specific resistance values of specific cutting work are deducted from cutting power consumption. The specific cutting work values characterizes the cross cutting of the pine wood. This values characterizing the values of the dynamic parameters. The specific cutting work represents a main factor to determining the values of power and cutting forces in milling. Also it characterizes the specific energy consumption for cutting.

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