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RESEARCHING ABOUT THE BEARING OF THE TUBULAR WIRES AND BI-METAL COMPONENTS FOR HARDENING THE SHARES OF THE PLOUGH BODY

CERCETĂRI PRIVIND COMPORTAREA SÂRMELOR TUBULARE SI A COMPONENTELOR BI-METAL UTILIZATE PENTRU DURIFICAREA BRĂZDARELOR DE LA TRUPIȚĂ

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Abstract. *The paper presents the comportment of some samples taken from the shares of the plough body after it was hardened before by depositing in alveolus using tubular wires with composite core. This comportment is showed by laboratory testing, on a specialized stand, realized so as it can distinguish the wear for different samples taken from plough body (hardened or unhardened) at intensive wear.*

Rezumat. *Lucrarea urmăreşte comportamentul unor probe prelevate din brăzdarul unei trupiţe după ce acesta a fost durificat în prealabil prin depuneri în alveole cu sârma tubulară cu miez compozit. Acest comportament este exemplificat prin testări în laborator, pe un stand specializat, realizat astfel încât să se poate scoate în evidenţă uzura diferitelor probe prelevate din trupiţă (durificate şi nedurificate) la uzură intensivă.*

Key words: *share, wear, welding, sample, friction, reliability*
Cuvinte cheie: *brăzdar, uzură, sudură, epruvetă, frecare, fiabilitate*

INTRODUCTION

In the actual conditions of development of the national economy agriculture can not be conceived without a height grade of mechanization.

Is known the facts that, in the car parts market prices, 70…80% are charges for the used materials.

These materials, when worn parts are reconditioned, can be used repeatedly. In the last years in Romania, are used more and more new techniques and new marks, made abroad.

To obtain spare parts for agricultural machinery is very expensive. So it is necessary to find new methods for reconditioning agricultural machinery parts, able to increase the reliability of agricultural techniques and manufacturing industry.

Share wearing intensity depends not only of soil condition, but also of its homogeneity grade with depth properties. If in 2-3 years, the tilt is not changed, share wears on the bottom of the furrow increases, cutting side would be in this case collateral with the bottom of the furrow.

Efficiency of using welding deposits for active operating parts hardening and reconditioning of the spare parts has been demonstrated by many researchers from our country and abroad, but actual recommendations refers mostly to certain parts, used in certain exploitation conditions.

Considering all these, in this study has been realized researches about physico-mechanical and wearing characteristics of the materials taken from a share with welding deposits, in alveolus, the new type of additional material (figure 1) - tubular wires with composite core, being realized by our partners Tehnomag and Sudotim.

The samples have been analyzed in our laboratories as follows.

THE ANALYSE OF THE PHYSICO-MECHANICAL CHARACTERISTICS. THE ANALYSE OF THE WEARING CHARACTERISTICS.

Analyze description

In this stage have been effectuated analyses for 5 samples taken from the areas presented in the next image, steel without any hardening, respectively from bead area.

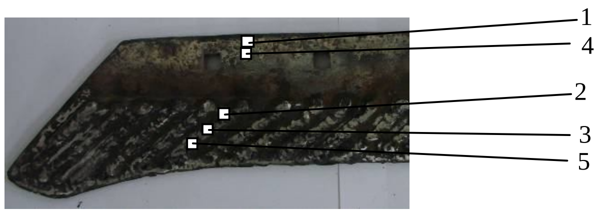


Fig. 1 – Assay areas of the samples
1,4 – not hardened steel samples
2, 3, 5 – bead area samples

It has been studied from physico-mechanical and wearing characteristics of the materials tested to friction, the following samples, in shape of pastilles, with parallelepiped geometry, with square base, 16 mm a side and variable height.

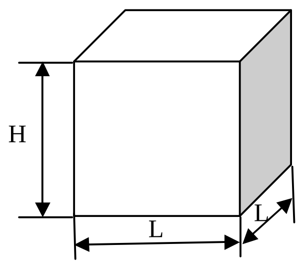


Fig. 2 – Sample geometry (L=16 mm, H – as in measurement file)

Samples has been cut with a *cutting machine with pump and cooling tank Mecatome T255/300*, then polished, using a *polishing machine MecapolP262*.

Fig. 3 – Cutting a sample from unhardened zone

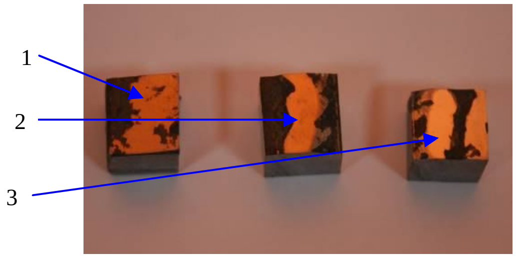


Fig. 4 – Polished samples, on the friction side of the share that works into the soil

Linear initial dimensions of the samples:

Table1

Measured dimensions	Sample 1	Sample a 2	Sample 3	Sample 4	Sample 5
L [mm]	16	16,5	15,5	16,36	16,16
l [mm]	15,4	14,2	14,5	14,59	15,46
h [mm]	13,2	14,6	13	13,6	14,67

The hardness has been measured with a *hardness-testing machine HMV Shimadzu*, that can convert Vickers hardness to Rockwell hardness.

Table 2

Sample number	Vickers hardness HV2	Rockwell hardness HRC	Conditions of testing
Sample 1	174	4,2	Applied force F= 19,61 N Pressure standing t= 45 sec
	177	5,1	
Sample 2	296	29,2	
	324	32,6	
Sample 3	324	32,6	
	305	30,3	
Sample 4	180	6	
	177	5,1	
Sample 5	347	35,2	
	325	32,7	

To determinate specifically friction properties (friction coefficient, wear intensity, friction coefficient stability), it has been used a special stand fig.5-7, with the possibility to measure necessary factors to determinate by calculating these measurements values.

Fig. 5 - Stand for testing samples to friction. Assembly view
1. cast-iron friction disc; 2.engine- disc gear; 3. weights set to realize the pressure

Fig. 6 – Testing stand. Detail with the measurement and control apparatus
1. tensometer amplifier; 2. electronic tachometer with digital display; 3. laptop with acquisition board to measure friction force; 4. digital thermometer; 5. digital calliper rule

Through the transmission from engine, friction cast-iron disc gets a rotating motion with constant speed. The sample is fixed in the chuck (fig. 8) then is put in contact with cast-iron disc, being controlled normal pressure on the disc with a calibrated weights set. The contact surface of the sample with the disc is calculated in table 1, and is represented by the square side of the sample. With the charging cell it is measured friction force that appears at the contact of the sample with the cast-iron disc, and that opposes the motion. Also it is known disc diameter and friction time is being registered, so that we can calculate road length and peripheral speed. At the beginning and at the end of each test, each sample was weighted.

Fig. 7 – Catching the sample in the chuck, detail

Testing stand represents a technical accomplishment witch can realize friction materials testing in dynamic regime, in initial conditions of temperature, sliding speed and preset pressing charge, starting with usual values to maximum admitted limits of the tested material.

Friction characteristics tests results

- **Determination of the friction coefficient (μ)**

Friction coefficient has been calculated:

$$\mu = \frac{F}{N},$$

when: F = measured friction force, in daN;

N = normal pressing force (daN);

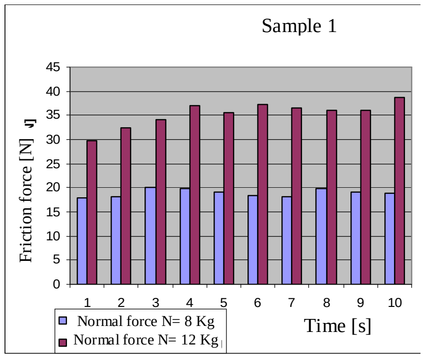
Average values calculated can be seen in tables 3-7.

The results of the tests are:

- **Determination of friction coefficient μ_{sample}**

Table 3

No. crt.	Sample 1- N= 8,535 daN			Sample 1- N= 12,46 Kg			$\mu_{sample1}$
	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}	
1	18	0,211		29,8	0,39		
2	18,05	0,211		32,3	0,259		
3	20	0,234		34,2	0,274		
4	19,8	0,232		37,1	0,298		
5	19	0,223	0,2218	35,5	0,285	0,02838	0,2528
6	18,4	0,216		37,2	0,299		
7	18,2	0,213		36,6	0,294		
8	19,9	0,233		36,1	0,29		
9	19,2	0,225		36	0,289		
10	18,8	0,22		38,8	0,311		



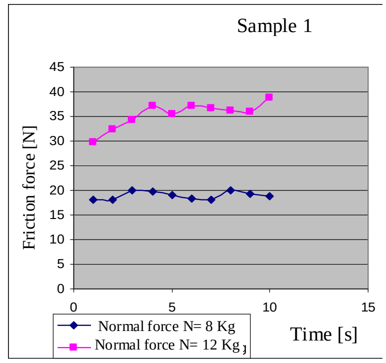
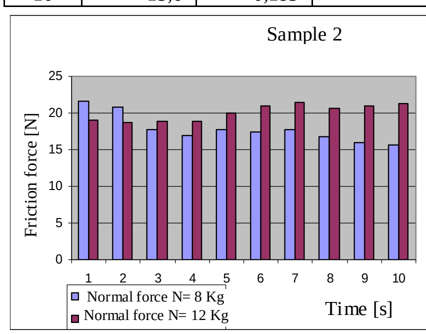


Table no. 4

No. crt.	Sample 2- N= 8,535 Kg			Sample 2- N= 12,46 Kg			$\mu_{sample2}$
	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}	
1	21,6	0,253	0,209	19	0,152	0,1613	0,185
2	20,8	0,244		18,7	0,15		
3	17,7	0,207		18,9	0,52		
4	17	0,199		18,8	0,151		
5	17,8	0,209		20	0,161		
6	17,4	0,204		21	0,169		
7	17,7	0,207		21,4	0,172		
8	16,8	0,197		20,7	0,166		
9	16	0,187		21	0,169		
10	15,6	0,183		21,3	0,171		



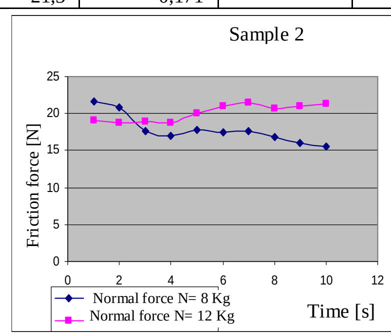
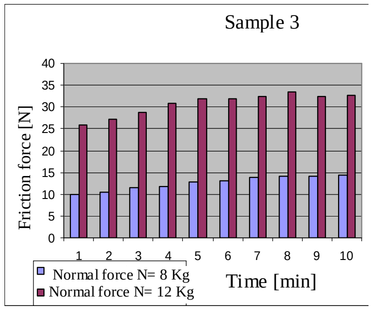


Table 5

No. crt.	Sample 3- N= 8,535 Kg			Sample 3- N= 12,46 Kg			$\mu_{sample3}$
	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}	
1	10	0,117	0,1477	26	0,209	0,2469	0,1973
2	10,5	0,123		27,3	0,219		
3	11,4	0,134		28,7	0,23		
4	11,8	0,138		30,9	0,248		
5	12,8	0,15		31,9	0,256		
6	13	0,152		32	0,257		
7	13,9	0,163		32,4	0.26		
8	14,1	0,165		33,5	0,269		
9	14,2	0,166		32,3	0,259		
10	14,4	0,169		32,6	0,262		



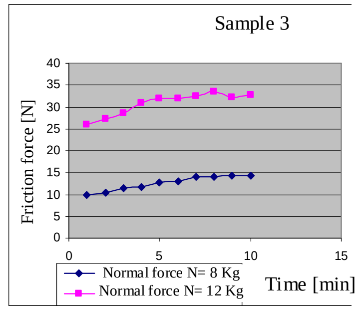
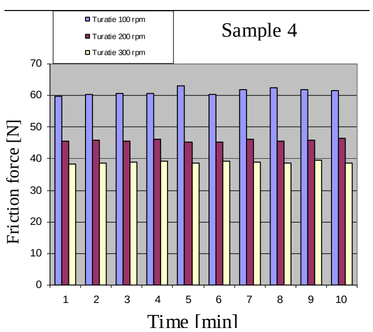


Table 6

No crt	Sample 4 n= 100 rpm			Sample 4 n= 200 rpm			Sample 4 n= 300 rpm		
	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}
1	59,7	0,48		42,2	0,37		38,4	0,31	
2	60,3	0,48		43,3	0,37		38,5	0,31	
3	60,5	0,49		41,6	0,37		38,8	0,31	
4	60,6	0,49		44,5	0,37		39,3	0,32	
5	63,1	0,051	0,491	43,4	0,36	0,368	38,7	0,31	0,312
6	60,2	0,48		43,6	0,36		39,2	0,31	
7	61,8	0,5		40,6	0,37		39	0,31	
8	62,6	0,5		45,3	0,37		38,5	0,31	
9	61,9	0,5		46,8	0,37		39,5	0,32	
10	61,7	0,5		45,2	0,37		38,7	0,31	



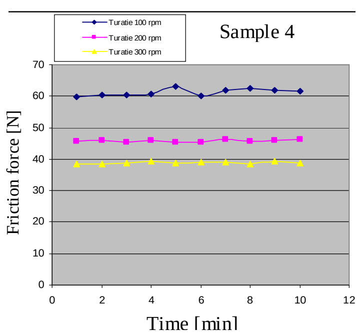
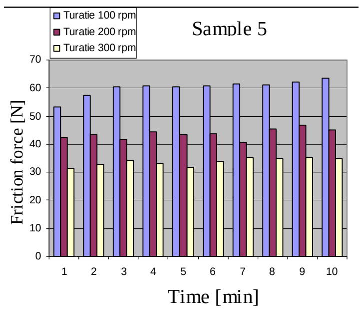
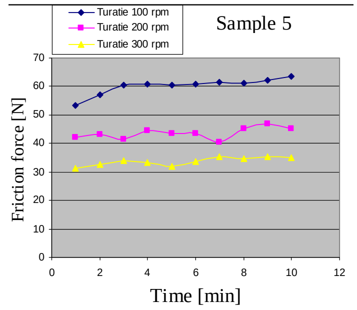


Table 7

No crt	Sample 5 n= 100 rpm			Sample 5 n= 200 rpm			Sample 5 n = 300 rpm		
	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}
1	53,4	0,43		42,2	0,34		31,4	0,25	
2	57,2	0,46		43,3	0,35		32,7	0,26	
3	60,6	0,49		41,6	0,33		34,1	0,27	
4	60,7	0,49		44,5	0,36		33,2	0,27	
5	60,5	0,49	0,484	43,4	0,35	0,351	31,9	0,26	0,27
6	60,9	0,49		43,6	0,35		33,7	0,27	
7	61,4	0,49		40,6	0,33		35,2	0,28	
8	61	0,49		45,3	0,36		34,7	0,28	
9	62,3	0,5		46,8	0,38		35,2	0,28	
10	63,4	0,51		45,2	0,36		35	0,28	





The results of wearing tests determinations

- **Wear intensity determination (I_{UZ})**

Wear intensity is the ratio between material wear mass express and consumed testing energy for the sample to run a given road.

$$I_{UZ} = \frac{U_{ZM}}{F_f * L} \quad \text{(g/daN*m)}$$

when:

U_{ZM} = material wear determined gravimetric, in gram;

F_f = friction force as the effect of pressing charge N, in daN;

L = road length run by he sample on the surface of the disc in a given time, in m.

Average values calculated can be found in tables 8 – 12.

a) Sample 1

Table 8

Material code	Sliping speed [m/s]	Normal force [daN]	Friction time [min]	Run road [m]	Medium friction force [N]	Friction Coef. µ	Contact surface [cm^2]	Weight [g]		Mass wear [g]	Wearing intensity [g/N*m]
								before	**after**		
Sample 1	11,52	8,535	10	6912	18,93	0,2218	2,46	25,0341	25,0178	0.0163	1,2457*10^{-7}
	11,52	12,46	10	6912	35,36	0,2838	2,46	25,0178	24,9492	0.0686	2,8067*10^{-7}

b) Sample 2

Table 9

Material code	Sliping speed [m/s]	Normal force [daN]	Friction time [min]	Run road [m]	Medium friction force [N]	Friction Coef. µ	Contact surface [cm^2]	Weight [g]		Mass wear [g]	Wearing intensity [g/N*m]
								before	after		
Sample 2	11,52	8,535	10	6912	17,84	0,2090	2,34	29,3849	29,0596	0.3253	26,380*10^{-7}
	11,52	12,46	10	6912	20,08	0,1611	2,34	29,0596	28,7303	0.3293	23,725*10^{-7}

c) Sample 3

Table 10

Material code	Slipping speed [m/s]	Normal force [daN]	Friction time [min]	Run road [m]	Medium friction force [N]	Friction Coef. µ	Contact surface [cm^2]	Weight [g]		Mass wear [g]	Wearing intensity [g/N*m]
								before	after		
Sample 3	11,52	8,535	10	6912	12,61	0,1477	2,24	23,4647	23,3495	0.1152	13,217*10^{-7}
	11,52	12,46	10	6912	30,76	0,2469	2,24	23,3495	23,1723	0.1772	8,3343*10^{-7}

d) Sample 4

Table 11

Material code	Rotation speed [rpm]	Sliping speed [m/s]	Normal force [daN]	Friction time [min]	Run road [m]	Medium friction force [N]	Friction Coef. µ	Contact surface [cm^2]	Weight [g]		Mass wear [g]	Wearing intensity [g/N*m]
									before	after		
Sample 4	100	2,094	12,46	10	1256,4	61,24	0,4914	2,38	24,9483	24,7801	0,1682	0,2186*10^{-7}
	200	4,188	12,46	10	2512,8	45,8	0,3676	2,38	24,7801	24,7711	0,009	0,78202*10^{-7}
	300	6,283	12,46	10	3769,8	38,86	0,3118	2,38	24,7711	24,7351	0,036	2,4574*10^{-7}

e) Sample 5

Table 12

Material code	Rotation speed [rpm]	Sliping speed [m/s]	Normal force [daN]	Friction time [min]	Run road [m]	Medium friction force [N]	Friction Coef. µ	Contact surface [cm^2]	Weight [g]		Mass wear [g]	Wearing intensity [g/N*m]
									before	**after**		
Sample 5	100	2,094	12,46	10	1256,4	60,14	0,4826	2,498	26,4980	26,4806	0,0174	2,30280*10^{-7}
	200	4,188	12,46	10	2512,8	43,65	0,3503	2,498	26,4806	26,4498	0,0308	2,80807*10^{-7}
	300	6,283	12,46	10	3769,8	33,71	0,2705	2,498	26,4498	26,4196	0,0302	2.37645*10^{-7}

Observations:

It can be observed, in the firs case of 3 samples, the fact that once we increased normal pressing charge from N= 8,535 Kg, to N= 12,46 Kg friction coefficient increased too, as a result of the friction between the disc and the sample, contact surface between these too increases too.

In the second case, samples 4 and 5, that has been tested in different regimes of rotation speed, respectively 100, 200 and 300 rot/min, it can be noticed obviously the tendency of decreasing of the friction coefficient once the speed increasing.

As it can be seen in figure *4* cutted samples although polished, they couldn't get the same friction surface, because the welding belt has an inferior thickness to the dimension needed to catch it on our testing stand, respectively 16x 16 mm. So, those three hardened samples, has been tested , in fact, to a higher pressing force, having the surface inferior to those 2 unhardened, this has negatively influenced the interpretation of wear intensity (tab.8-12).

So it's been decided to effectuate a new series of tests with other four samples, cutted: two from hardened zone (samples 6 and 8) and other two unhardened (samples 7 and 9), adapted to a good catch in our tasting stand, but worked on a lathe to a diameter of 8 mm, so the friction surface to be the same for all 4 and to contain in the whole the welding belt of adding material, as can be seen in following pictures (figure 9).

Figure 9

Samples has been polished, then was determined their hardness with a *micro-hardness-testing machine HMV Shimadzu* (tab. 13).

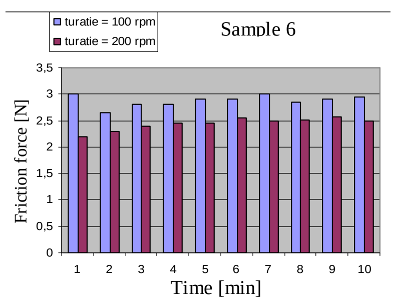
Table 13

Sample number	Vickers hardness HV2	Rockwell hardness HRC	Conditions of testing
Sample 6	256	23,3	Applied force F= 19,61 N Standing pressing t= 45 sec
	251	22,5	
Sample 7	351	35,6	
	358	36,4	
Sample 8	229	17,7	
	232	18,5	
Sample 9	621	56,4	
	682	59,3	

Determination of the friction medium coefficient μ_{med}, has been made by measuring friction force every minute, for ten minutes.

Table 14

Crt No.	Sample 6 (n= 100 rpm)			Sample 6 (n= 200 rpm)		
	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}
1	3	0,0667	0,06389	2,2	0,0489	0,05436
2	2,65	0,0589		2,3	0,0511	
3	2,8	0,0622		2,4	0,0533	
4	2,8	0,0622		2,45	0,0544	
5	2,9	0,0644		2,45	0,0544	
6	2,9	0,0644		2,56	0,0569	
7	3	0,0667		2,5	0,0556	
8	2,85	0,0633		2,52	0,0560	
9	2,9	0,0644		2,58	0,0573	
10	2,95	0,0656		2,5	0,0556	



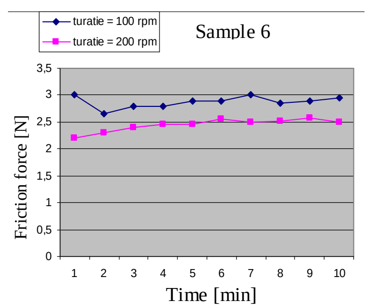
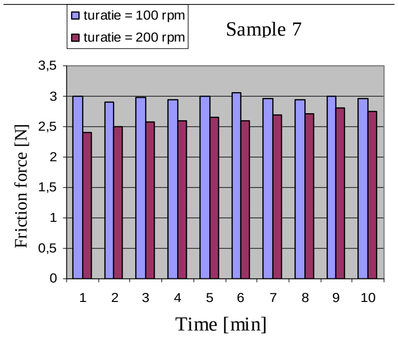


Table 15

Crt No.	Sample 7 (n= 100 rpm)			Sample 7 (n= 200 rpm)		
	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}
1	3	0,0667	0,06611	2,4	0,0533	0,05844
2	2,9	0,0644		2,5	0,0556	
3	2,98	0,0662		2,58	0,0573	
4	2,94	0,0653		2,6	0,0578	
5	3	0,0667		2,65	0,0589	
6	3,05	0,0678		2,6	0,0578	
7	2,97	0,0660		2,7	0,0600	
8	2,95	0,0656		2,72	0,0604	
9	3	0,0667		2,8	0,0622	
10	2,96	0,0658		2,75	0,0611	



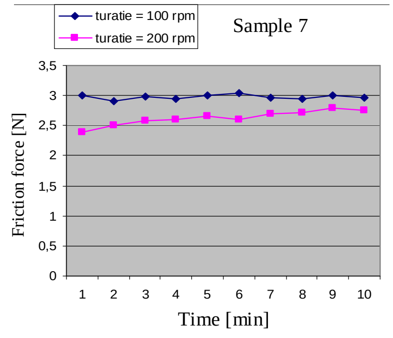
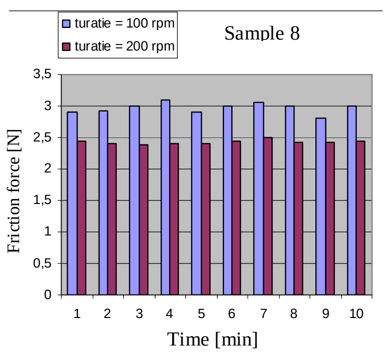


Table 16

Crt No.	Sample 8 (n= 100 rpm)			Sample 8 (n= 200 rpm)		
	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}
1	2,9	0,0644	0,06593	2,45	0,0544	0,05396
2	2,92	0,0649		2,4	0,0533	
3	3	0,0667		2,38	0,0529	
4	3,1	0,0689		2,4	0,0533	
5	2,9	0,0644		2,4	0,0533	
6	3	0,0667		2,45	0,0544	
7	3,05	0,0678		2,5	0,0556	
8	3	0,0667		2,43	0,0540	
9	2,8	0,0622		2,42	0,0538	
10	3	0,0667		2,45	0,0544	



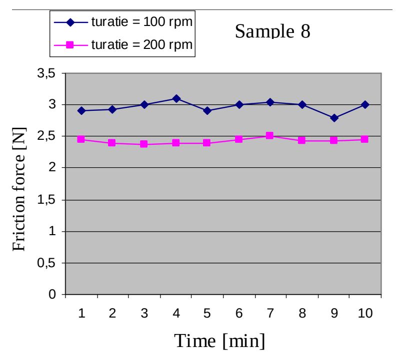
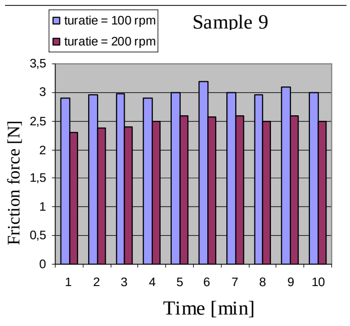
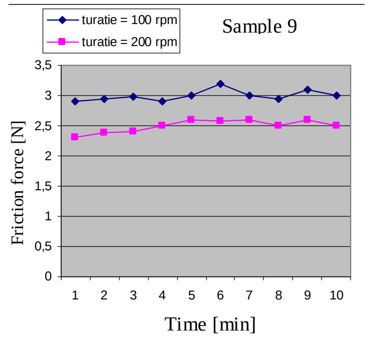


Table 17

Crt No.	Sample 9 (n= 100 rpm)			Sample 9 (n= 200 rpm)		
	Ff [N]	μ	μ_{med}	Ff [N]	μ	μ_{med}
1	2,9	0,0644	0,06662	2,3	0,0511	0,05547
2	2,95	0,0656		2,38	0,0529	
3	2,98	0,0662		2,4	0,0533	
4	2,9	0,0644		2,5	0,0556	
5	3	0,0667		2,6	0,0578	
6	3,2	0,0711		2,58	0,0573	
7	3	0,0667		2,6	0,0578	
8	2,95	0,0656		2,5	0,0556	
9	3,1	0,0689		2,6	0,0578	
10	3	0,0667		2,5	0,0556	





a) Sample 6

Table 18

Material code	Rotation speed [rpm]	Sliding speed [m/s]	Normal force [daN]	Frictio n time [min]	Run road [m]	Medium friction force [N]	Friction Coef. µ	Contact surface [cm^2]	Weight [g] before	Weight [g] after	Mass wear [g]	Wearing intensity [g/N*m]
Sample 6	100	2,094	4,5	10	1256,4	2,875	0,0638	0,5	19,8495	19,8353	0,0142	$39,3117*10^{-7}$
	200	4,188	4,5	10	2512,8	2,446	0,0543	0,5	19,8353	19,8015	0,0338	$54,9923*10^{-7}$

b) Sample 7

Table 19

Material code	Rotation speed [rpm]	Sliding speed [m/s]	Normal force [daN]	Frictio n time [min]	Run road [m]	Medium friction force [N]	Friction Coef. µ	Contact surface [cm2]	Weight [g] before	Weight [g] after	Mass wear [g]	Wearing intensity [g/N*m]
Sample 7	100	2,094	4,5	10	1256,4	2,975	0,0661	0,5	24,4004	24,3917	0,0087	$23,2757*10^{-7}$
	200	4,188	4,5	10	2512,8	2,630	0,0584	0,5	24,3917	24,3560	0,0357	$54,0199*10^{-7}$

c) Sample 8

Table 20

Material code	Rotation speed [rpm]	Sliding speed [m/s]	Normal force [daN]	Frictio n time [min]	Run road [m]	Medium friction force [N]	Friction Coef. µ	Contact surface [cm2]	Weight [g] before	Weight [g] after	Mass wear [g]	Wearing intensity [g/N*m]
Sample 8	100	2,094	4,5	10	1256,4	2,967	0,0659	0,5	21,8951	21,8337	0,0614	$164,711*10^{-7}$
	200	4,188	4,5	10	2512,8	2,428	0,0539	0,5	21,8337	21,8088	0,0249	$40,8124*10^{-7}$

d) Sample 9

Table 21

Material code	Rotation speed [rpm]	Sliding speed [m/s]	Normal force [daN]	Frictio n time [min]	Run road [m]	Medium friction force [N]	Friction Coef. µ	Contact surface [cm^2]	Weight [g] before	Weight [g] after	Mass wear [g]	Wearing intensity [g/N*m]
Sample 9	100	2,094	4,5	10	1256,4	2,998	0,0666	0,5	22,0554	22,0514	0,004	$10,6194*10^{-7}$
	200	4,188	4,5	10	2512,8	2,496	0,0554	0,5	22,0514	22,0265	0,0249	$39,7005*10^{-7}$

CONCLUSIONS

As samples 4 and 5, that has been tested in different speed regimes, we've effectuated tests also for this last series at rotation speed 100 respectively 200 rot/ min, using a normal pressing charge of 4,5 Kg. This time can been observed a decreasing of the friction coefficient once the rotation speed increases, too.

Also, for each testing set, samples has been weighted before and after, so it can be calculated mass wear after every ten minutes. For unhardened samples 6 and 8 this is even greater.

We've considered concluding this last testing series because we've did it in the same initial conditions for all four samples. So, with 7 and 9 samples, hardened with the new type of tubular wire with composite core, for which wearing intensity is obviously lower, relieves that they have a higher hardness and wear resistance, in laboratory conditions.

BIBLIOGRAFY

1. BRAHARU D, GÂNGU V, ş.a. – Fundamental research regarding the methods of anti-wear deposit, adaptable to components for agricultural equipments, Bucharest, 2007
2. DUMITRU TOMESCU, GHE. MANCIU, VALENTIN S. – Agricultural machinery reliability, Bucharest, 1981;
3. RADU IOVĂNAŞ, DANIELA M. IOVANAŞ – Reconditioning and the recovery of the welded parts, Editor UTB, 2006