SOIL TESTS OF RENOVATED PLOUGHSHARE POINTS

Peter ČIČO[1], Róbert DRLIČKA[1], Radovan ŠOŠKA[1], Zdenko RÓNA[2]

[1]Department of Quality and Mechanical Engineering, Faculty of Engineering, Slovak University of Agriculture in Nitra, Slovak Republic
[2]Transmisie Engineering, a. s. Martin, Slovak Republic

Abstract
The paper deals with operational (soil) tests of selected hardfacing materials allowing extend the life of the ploughshare point. The results showed that the highest wear occurred in the front part of the ploughshare points. EB 520 RB with ledeburitic structure and chromium and vanadium carbides has achieved the highest wear resistance among the materials studied. The ploughshare points welded with the NiCrBSi-based NP 60 WC 20 powder also achieved a relatively high wear resistance. High wear resistance values are mainly due to the presence of tungsten carbide hard structures. NP 62, also based on NiCrBS, but without tungsten carbide particles, has achieved significantly lower wear resistance.

Key words: *ploughshare point; wear; deposit; soil tests.*

INTRODUCTION

In agriculture, various processing tools are used which counter degradation processes during operation. Wear of cutting edges of working tools in operating conditions significantly affects the quality of work and energy demands of soil tillage processes (*Hrabě & Müller, 2013; Kováč, Vanko & Vysočanská, 2014; Mikuš, Balla & Žernovič, 2006; Müller & Hrabě, 2013*).
Farmers and suppliers are looking for different ways to extend the technical life of working tools. One option is to apply materials with increased hardness to the working part of the tool, which is expected to achieve increased wear resistance in the soil. There are several ways of creating hard layers, which are distinguished from each other by technological parameters, filler materials used, as well as by the properties of the created hard layers (*Hrabě, Chotěborský, Ružbarský & Žarnovský, 2010; Kováč, Vanko & Vysočanská, 2014; Viňáš, J., Brezinová, J., Guzanová, A., & Kotus, M., 2013*).
The application possibilities of specific wear resistant materials can be verified in laboratory tests. Despite the excellent results of some materials in laboratory conditions, the results in operational tests will not conform to these evaluations. The evidence can be found in the results of several authors (*Brožek, Nováková & Mikuš, 2010; Mikuš, Kováč & Žarnovský, 2014; Müller & Hrabě, 2013*).
The most accurate results of soil resistance of materials in soil conditions can be obtained through operational tests. It should be noted that the same type of material may have quite different wear values in various operating or soil conditions. These differences are influenced by several factors, e.g. soil (soil type, soil moisture), tillage tool (material and geometry of the tool) and so on (*Hrabě & Müller, 2013; Mikuš, Balla & Žernovič, 2006*).
Therefore, the aim of this paper is to find out the possibilities of extending the life of the ploughshare point by welding-on the selected wear resistant materials and to evaluate the wear on the basis of operational tests.

MATERIALS AND METHODS

The operating tests were focused to examining the wear of the most exposed part of the plough - ploughshare point. A total of fourteen ploughshare points included in the experiment were mounted on the plough Ostroj Europa. The two original ploughshare points were used as a standard, the remaining twelve ploughshare points (divided into three parts by four) were welded-on with two types of powder filler materials based on NiCrBSi (NP 62 and NP 60 WC 20) and hardfacing rod (E 520 RB). The chemical composition of the additive materials used is shown in Tab. 1.

Tab. 1 Chemical composition and hardness of the filler materials used

	Standard chemical composition (% weight)									Hardness HRC
Filler material	**C**	**Si**	**B**	**Fe**	**Cr**	**WC**	**V**	**Mn**	**Ni**	
NP 62	0,9	5,5	4	5	20	-	-	-	remainder	58-65
NP 60 WC 20	0,6	5	3,9	5	20	20	-	-	remainder	75-82
E520 RB	3,5	0,8	-	-	25	-	1,7	0,8		61

The powder filler materials NP 62 and NP 60 WC 20 were applied by an oxygen-acetylene flame (NPK-3 torch, neutral flame, 3-4 mm.s $^{-1}$ welding speed). The material E 520 RB was applied by manual metal arc welding-on (direct current, positive electrode, welding current 80 to 100 A, welding voltage 24 to 25 V, welding speed 3-4 mm.s $^{-1}$). Before welding, grooves with a width of 20 mm and a depth of 2 mm were machined on the front face (Fig. 1). The grooves were then filled with deposit materials, with a weld thickness of 2 mm. The same geometric shape as in case of the original ploughshare points were achieved by this way.

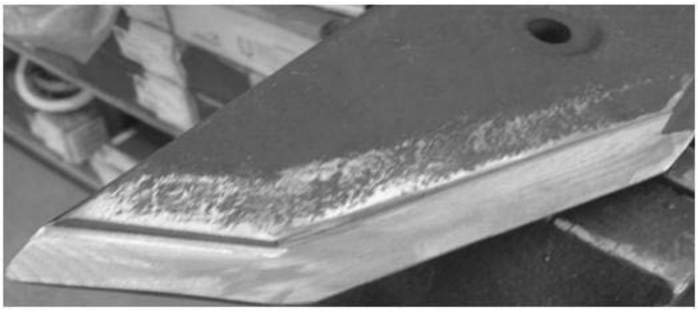

Fig. 1 Groove for hardfacing on the functional face part of the ploughshare point

In operational tests, the size of the linear wear of the ploughshare point was monitored after the 40 and 80 ha area processed. Wear was determined as the difference between the dimensions in the defined planes (Fig. 2) of original and worn ploughshare points after specific area ploughed. The measurements were made with a calliper with an accuracy of 0.02 mm.

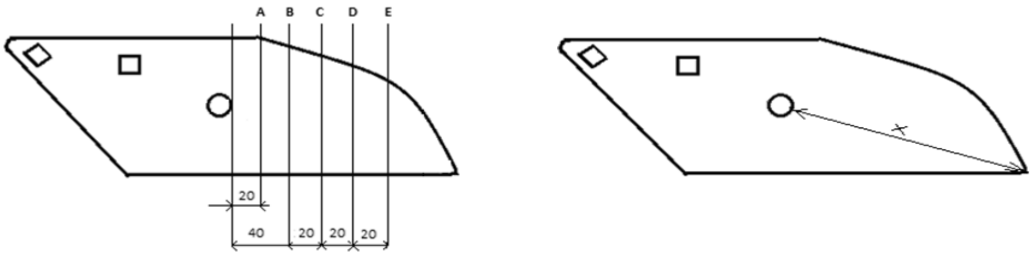

Fig. 2 Measurement planes of linear wear of the ploughshare point

RESULTS AND DISCUSSION

Field tests were realized in loam soil with moisture of 17.5%. The first ploughshare point wear measurement was carried out after 40 h of ploughed area and the results obtained are shown in Fig. 3. The highest wear was found on the standards. The arithmetic mean of their linear loss was 3.32 mm. The lowest wear was achieved by ploughshare point hardfaced with the material E 520 RB, the average loss reached the value of 1.76 mm in the defined planes, which represents 88% better wear resistance compared to standards. Ploughshare points welded-on with NP 62 powder material reached average loss of 1.83 mm width (81% better wear resistance compared to standards) and ploughshare points hardfaced with NP 60 WC 20 reached an average width loss of 2.11 mm (57% better wear resistance compared to standards). The largest lost in linear dimensions were identified in the X plane

(Fig. 2). NP62 deposit was 65.6% better than the standard, NP 60 WC 20 was 148% and the EB 520 RB was 162% more durable than not hardfaced ploughshare point.

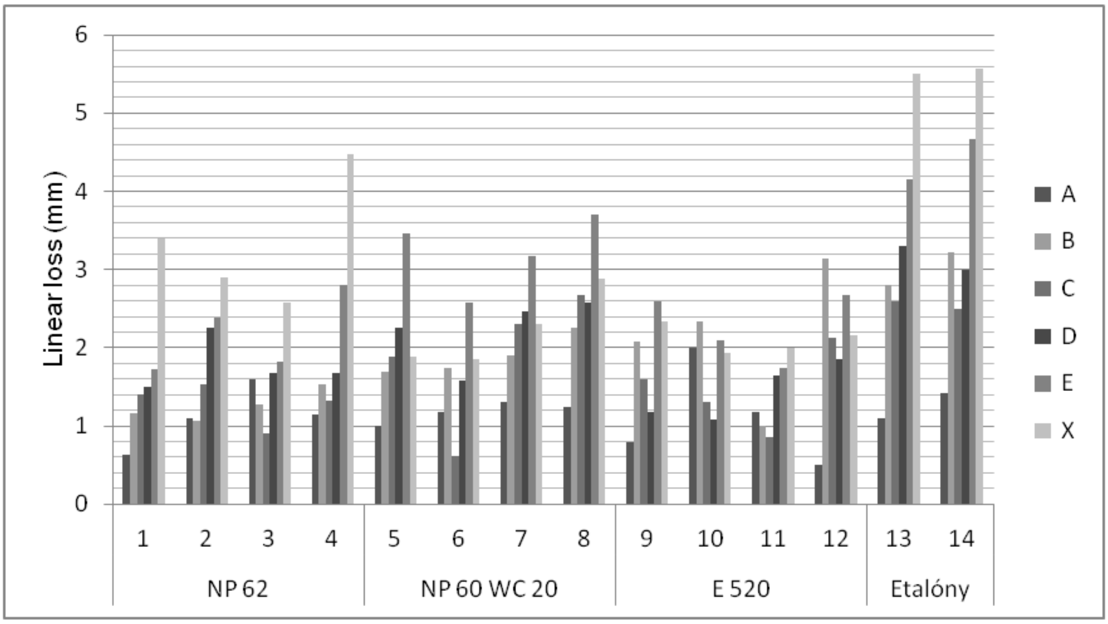

Fig. 3 Linear loss of ploughshare point after 40 ha of ploughed area

The following measurements were made after 80 ha of ploughed area, with average soil moisture of 16.8%. The values of linear loss of the ploughshare point are shown in Fig. 4. The standards showed the highest wear. Their average linear loss in the measured planes was 6.42 mm. E 520 RB with an average linear loss of 3.15 mm, the 103% increase in wear resistance versus standards, achieved the best results from the filler materials. Metal powders had similar losses after ploughing 80 ha. The NP62 deposit achieved an average loss of 3.66 mm (75% better wear resistance compared to standards), the NP 60 WC 20 achieved an average loss of 3.87 mm (65% better wear resistance than standards). Again, the greatest wear was recorded in the X plane (Fig. 2), with the NP62 deposit 70.2% better value than the standard, the NP 60 WC 20 176% and the EB 520 RB 183.5% better durability as not welded ploughshare points.

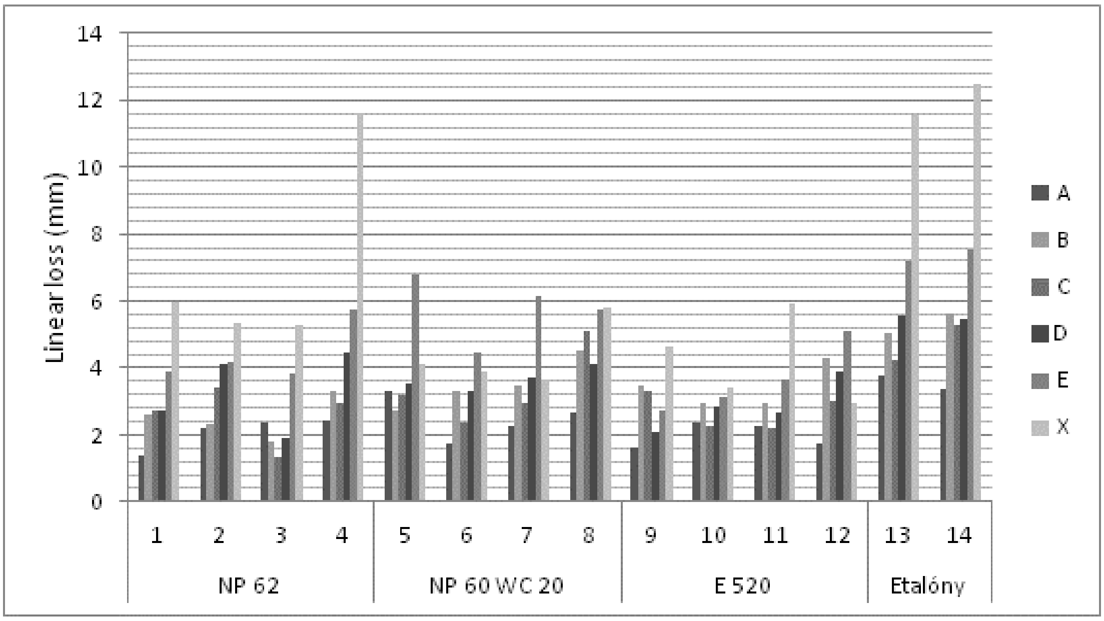

Fig. 4 Linear loss of ploughshare points after 80 ha of ploughed area

The results achieved fully correspond to the results presented by several authors in their works (*Hrabě & Müller, 2013; Kováč, Vanko & Vysočanská, 2014; Mikuš, Balla & Žernovič, 2006; Müller & Hrabě, 2013; Viňáš, J., Brezinová, J., Guzanová, A., & Kotus, M., 2013*). The material NP 60 WC 20 wear of the ploughshare point cutting edge was positively influenced by the presence of WC particles in the structure, being significantly reduced in comparison to the material NP 62, which is in accordance with the results reported by *Mikuš, Balla & Žernovič, 2006; Mikuš, Kováč & Žarnovský, 2014.* EB 520 RB achieved the best results from all materials tested, which can be attributed mainly to the presence of ledeburitic structure (high carbon content) as well as chromium and vanadium carbides in the material structure. The carbide structure seems to be the most suitable in terms of the wear resistance in the soil environment (*Hrabě, Chotěborský, Ružbarský & Žarnovský, 2010*).

CONCLUSIONS

The results achieved showed that the highest wear was in the first third of ploughshare point. When comparing the wear at the particular measuring points, it can be stated that the ploughshare points welded-on with EB 520 RB with ledeburitic structure and chromium and vanadium carbides have the best wear resistance. The ploughshare points hardfaced with NP 60 WC 20 also have 150 to 180% higher resistance comparing to standards. High wear resistance values are mainly due to the presence of hard tungsten carbide structures. The material NP 62, without tungsten carbide particles, was only 70-80% higher than the standards.

Protective deposit can therefore prolong significantly the technical life of the ploughshare point. This issue needs to be further explored and new possibilities for extending the lifetime and reducing the cost of operating tools are sought.

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Corresponding author:
doc. Ing. Peter Čičo, CSc., Katedra kvality a strojárskych technológií, Technická fakulta SPU v Nitre, Tr. A. Hlinku 2, 949 76 Nitra, Slovensko. Tel.: +421376415686, e-mail: peter.cico@uniag.sk