Stara Dąbia, November 16, 2018

Report
from testing the prototype sieve in field conditions in the 2018 season

I. <u>Diagnosis of problems</u>

1) The rapid development of grain corn production has led to a situation in which the corn harvesting process takes place under very different atmospheric conditions. Large farms keep harvest from September until late winter months. Due to the need for continuity of the dryer's work or completion of the harvesting, many producers decide to harvest during rain or even wet snow. Harvesting in such extreme conditions creates big problems with sieves clogging. The currently used lamella for harvesting corn CZ3 (Fig. 1) is clogged and requires mechanical cleaning, which causes rapid destruction of the sieves. Observation of the clogging process allowed to conclude that the solution to the problem could be **a change in the geometry of the lamella (Fig.2).** The lamella geometry has been changed so that the contour of the lamellas is a section of the ellipse. Such a solution - according to the developers - will allow to lower the tip of the tooth, from which the clogging process begins.

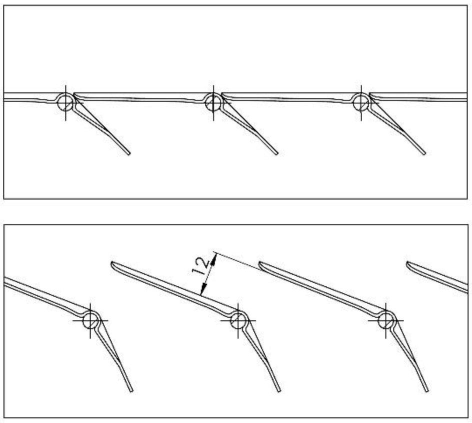

Fig. 1 The geometry of the CZ3 lamella in the closed position and in the open position at 12mm.

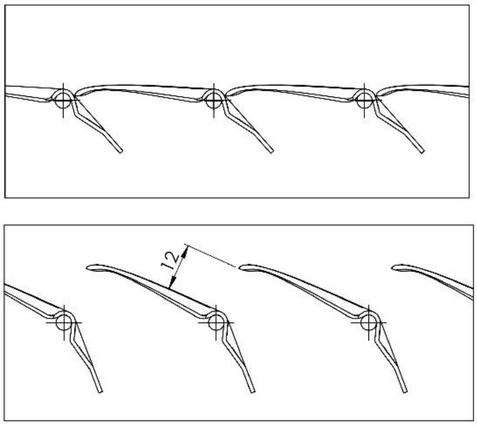

Fig. 2 The geometry of the CZ3m lamella in the closed position and in the open position at 12mm.

2) The second issue that creates problems is the durability of fixing the lamellas to the axis of rotation. The commonly used method of welding is sometimes unreliable (Phot.1). Breaking away from the axis of rotation is a big problem, because the lamella falls together with the grain into the grain elevator and causes its blockage or even more serious failure, when the sieve requires disassembly and specialized repair.

Photo 1 A fragment of a damaged sieve, made by welding the lamella to the axis of rotation.

The solution that we propose is the use of **hole welding** instead of spot-welding. This method gives a connection with much better strength parameters due to a larger weld cross-section (Photo 2) than a weld (Photo 3)

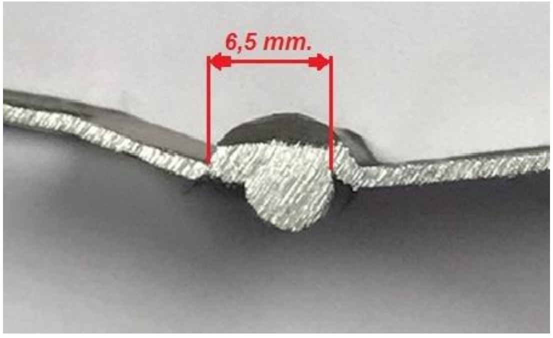

Photo 2 Cross-section through the hole weld which fasten lamella to the axis of rotation, after plastic deformation initiating the breaking process.

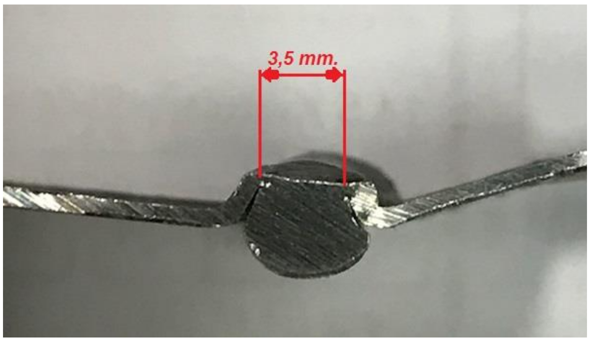

Photo 3 Cross-section through the weld which fasten lamella to the axis of rotation, after plastic deformation initiating the breaking process.

3) The third problem faced by farmers during the exploitation of sieves is their mechanical wear. It consists in wiping the axis of rotation of the lamellas (Photo 4) and wiping the holes in the frame (Photo 5).
   The basic factor that accelerates mechanical wear is the excessive clearance between the axis of rotation and the sieve frame (Photo 6).

Photo 4 The diameter of the axis of rotation of the lamella after removal from the frame (nominal diameter 3.8 mm).

Photo 5 Diameter of the hole in the sieve frame (nominal diameter d = 3.9 mm).

Photo 6 Excessive clearance between the axis of rotation of the lamellas and the sieve frame in the sieve removed from the combine harvester.

It is assumed that the correct clearance should be L = 0.1 +/- 0.05 mm. Achieving such a level of accuracy is quite difficult due to the fact, that on 1 m^2 of sieve, there are about 100 - 150 connections. The solution that we propose is use the plastic **plain bearings** (Fig.3).

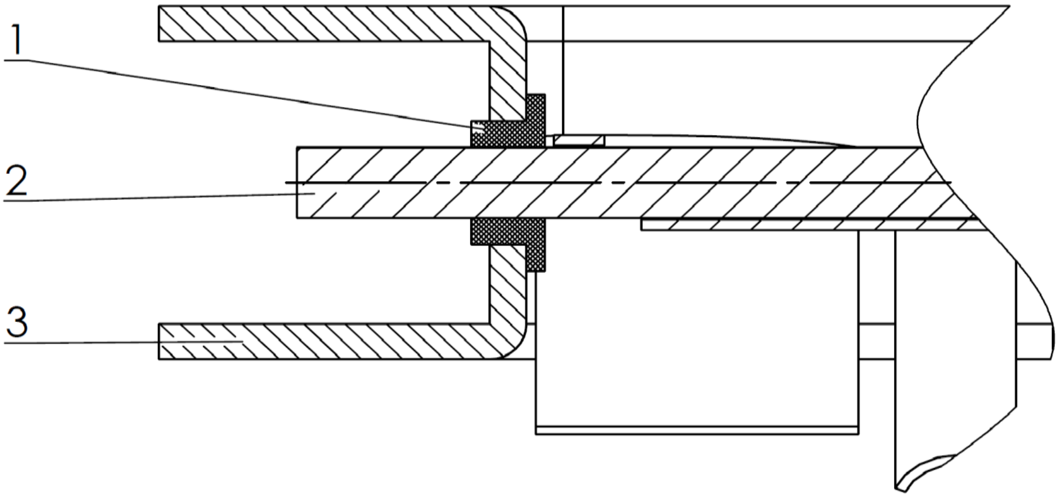

Fig. 3 The way of bearing for rotation (2) in the sieve frame (3) with a plain bearing (1).

The bearing according to our concept protects against excessive mechanical wear and additionally dampens the vibrations created during the sieve work. The above solution has been patented by us and is protected by **the Patent Office of the Republic of Poland by the patent No. P.413386.**

II. Choosing a farm for testing

Preparing to make the sieve according to the design assumptions described in point I, we were looking for a large farm in which the sieve could be subjected to a long-lasting examination. We also wanted the test results to be as objective and reliable as possible. Therefore, we asked for the help of **editor Przemysław Olszewski from the Agricultural Technical Review**. The offer was accepted and the editor Przemysław proposed tests on the farm of **Mr. Marcin, near Toruń**. An analysis of Mr. Marcin's experience in using various combines shows that the above problems also occurred in his combine harvesters.

Taking into consideration the technical capabilities of OSKO - PLAST Ostrzyżek, Kostyra sp. j. company, together with the editor Przemysław Olszewski from the Agricultural Technical Review and the farmer Mr. Marcin, we decided to make a prototype sieve for the combine and subject it to field testing in his farm near Toruń.

III. Technical description of the sieve

The sieve was designed and manufactured at OSKO - PLAST Ostrzyżek, Kostyra sp. j. company, in accordance with the engineering art and with the conclusions resulting from the analysis of the use of sieves.

Design assumptions

1) Steel frame made of cold bent profiles, MIG - MAG welded.
2) A geometrically modified lamella with the CZ3m symbol, designed and made at OSKO - PLAST Ostrzyżek, Kostyra sp. j. company.
3) Fitting the lamellas to the rotation axis by manual hole welding (in the future due to the higher quality of welds and repeatability it is desirable to welding in a welding robot).
4) Bearing bushings made of special material according to patent No. P.413386, all transitions to the frame rotation (in this case we used 441 bearing sleeves).
5) Made and folded sieve, completely galvanize and cover the substance reducing the coefficient of friction on the lamella.

IV. Assessment of the technical condition of the prototype screen after the harvesting season 2018

During the entire period of use in 2018, the sieve worked about 160 hours. After the end of the season, it was disowned, carefully examined and has been tested. The external examination did not show any cracks or micro cracks within the sieve frame, as well as within 945 holes of the lamellas welds fixing the lamellas to the axis of rotation. Separate tests were carried out on the clearance between the axis of rotation of the lamellas and the sliding bearing. The loses created during operation were measured using a dial indicator attached to the sieve frame. The attached sensor was zeroed in the position of the lower axis of rotation (Photo 7),

Photo 7 Zero sensor in the lower position of the lamella rotation axis.

and then the axle was raised to the upper position using a screwdriver (Photo 8).

Photo 8 The sensor indicates a deviation of 0.09 mm. in the upper position of the axis of rotation of the lamellas.

The above test has been repeated many times at various sieve points. The measured clearance was in the range of L = 0.03 mm. up to L = 0.09 mm. This is much less than the clearance allowed in the brand new sieve (clearance according to the works standard is L_{max} = 0.15 mm).

V. <u>Final conclusions</u>

The work of a prototype sieve during the entire corn harvesting period allows to formulate the following final conclusions::

1) The use of **<u>CZ3m</u>** lamellas protects the sieves against clogging, which increases the efficiency of the sieve (we do not waste time on cleaning) and protects it against mechanical damage during cleaning. **<u>The lamella works in all weather conditions.</u>**

2) The use of hole welds instead of spot-welds for installing lamellas to the axis of rotation increases their mechanical strength, protects against falling off and from changing position relative to the axis of rotation. The sieve after working for about 160 hours continues to close on the entire surface evenly (Photo 9),

Photo 9 Sieve with CZ3m lamella with the first closed section and the second open section at 12 mm. - after 160 hours of work.

which was impossible to achieve in the sieve with welded lamellas (Photo 10).

Photo 10 Sieve with CZ3 lamella with visible deformation of lamellas after 140 hours of operation.

The experience gained during using sieves with hole-welded lamellas allows the recommendation of **hole welding** as a more durable and more reliable solution in all types of lamellas.

3) The use of **plain bearings** between the axis of rotation and the frame has proved that the process of mechanical wear of the axle and the frame has been largely limited. The disadvantage of using plain bearings is the increase in the sieve price by approximately 30%. However, the service life of the sieve is longer and the economic effect in the whole period of using the sieve is positive, which is why we suggest using bushings in all types of lamellas.