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TOOLS FOR SHAPING SLOPES, DESILTING AND PERFORMING NEW WATERCOURSES WITHIN THE NEW TECHNOLOGY FOR REGENERATION OF OPEN WATERCOURSES

Summary

The basis of the new technology for watercourses is to use a new range of tools developed by the Industrial Institute of Agricultural Engineering for the maintenance and regeneration of drainage ditches. The tools are used to desilt and shape the bottom, profile existing ditches, as well as to create new watercourses.
***Key words**: melioration technology, melioration machines, tools, machine exploitation*

NARZĘDZIA DO KSZTAŁTOWANIA SKARP, ODMULANIA ORAZ WYKONYWANIA CIEKÓW WODNYCH W RAMACH NOWEJ TECHNOLOGII REGENERACYJNEGO KSZTAŁTOWANIA OTWARTYCH CIEKÓW WODNYCH

Streszczenie

Podstawą nowej technologii kształtowania cieków wodnych jest wykorzystanie nowej gamy narzędzi opracowanych w Przemysłowym Instytucie Maszyn Rolniczych do konserwacji i regeneracji rowów melioracji szczegółowej. Powstałe narzędzia służą do odmulania dna oraz kształtowania i profilowania istniejących skarp, jak również do wykonywania nowych cieków.
***Słowa kluczowe**: technologia melioracji; maszyny w melioracji, narzędzia, eksploatacja maszyn*

1. Introduction

One of the main problems during maintenance and renovation works in open watercourses consists in the obstruction of the channel, caused by excessive silting of channels, which leads to the obstruction of the free water flow on the bottom of the ditch. Rainwater flowing down the slopes to the ditch, washes down the slope and silts up the bottom with floating soil particles. Even a properly executed drainage ditch silts with the time and stops draining properly, where the landslide slope and ditch gradually cease to fulfill its role.

It`s important to maintain correct profile slopes and expected longitudinal bottom dip in the regeneration of watercourses. This aspect is important in order to keep the free water flow inside the ditch. In Addition to the removal of water plants during the maintenance of watercourses, it`s necessary to repair all damages occurred during the exploitation [2]

The silts and organic fractions (leaves, plants, branches) are removed during the low water level in the late summer and autumn. During this period, the drainage channels are normally dry, and the flow of those with permanent flow is on its minimum. The watercourses must be drained along their whole length through the year in order to keep the free flow of water and to avoid local flooding occurring mainly in early spring. This requires responsibility and conscientiousness of the owners in carrying out the maintenance of watercourses [5].

There is a lack of effective mechanized solutions and technologies on the market, which allows to perform basic maintenance work in the inner space of the ditches. In this regard, tools for removing silt from the bottom of watercourses and shaping the slopes were developed within the research and development project*) at the Industrial Institute of Agricultural Engineering. Additionally, the newly developed technology to maintain the ditches, also allows the use of these tools to create new small watercourses.

2. Shaping slopes in watercourses

Soil regenerator FSZ 200 (fig.1), developed at PIMR [3] is the main tool for shaping slopes and cutting with profiling roadside.

Source: own work / Źródło: opracowanie własne

Fig. 1. The Soil regenerator FSZ 200
Rys. 1. Frez ślimakowy FSZ 200

Main parameters of the soil regenerator:

- working width: 200 cm,
- cutting height: 10 - 20 cm,
- the feed rate: 2 – 5 km/h,
- flow at rated speed: 60-120 l/min,
- hydraulic pressure: do 250 bar,
- power consumption: 30 kW,
- weight: 750 kg,
- overall dimensions with the plow (L x W x D): 280 x 110 x 108 cm,
- overall dimensions without the plow (L x W x D): 250 x 55 x 108 cm.

The task of the soil regenerator consists in shearing surface layer of the slopes to restore a standard profile of the

ditch and removing vegetation overgrowing the slope (fig. 2). The rotating screw header with a plow extracts a silt from the bottom and material from the slopes beyond the ditch. The cutter can be mounted on the rear three-point hitch or on a standard excavator arm with an unladen weight of minimum 10T [4]. Effects of the work is illustrated in fig. 3.

Source: own work / Źródło: opracowanie własne

Fig. 2. Tests of the soil regenerator on the excavator arm
Rys. 2. Testy freza ślimakowego na wysięgniku koparki

Source: own work / Źródło: opracowanie własne

Fig. 3. Condition of watercourse; the photo at the top shows a ditch before milling the slopes, and below the photo shows a ditch after milling the slopes
Rys. 3. Stan cieku melioracyjnego; zdjęcie na górze pokazuje rów przed kształtowanie skarp, zdjęcie poniżej pokazuje ciek po kształtowaniu skarp

Source: own work / Źródło: opracowanie własne

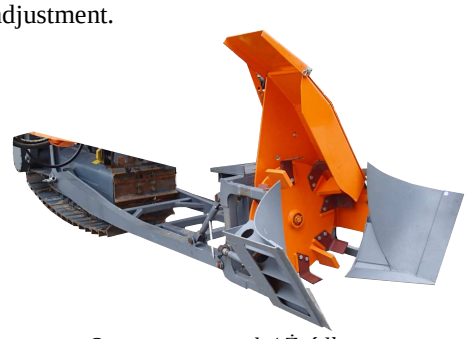
Fig. 4. Slopes shaping using with a backhoe bucket
Rys. 4. Kształtowanie skarp za pomocą łyżki podsiębiernej

Furthermore it is possible to shape slopes for ditch profile reconstruction using an excavator bucket suspended on front arm of multi-task machine (fig. 4). This technology is used often in the case of formation of small drainage ditches with low slopes and low water level.

The standard backhoe bucket can be changed for wider ditch-cleaning bucket.

3. Silt and sediments disposal in open watercourses

In the new technology of shaping open watercourses it has been developed scraping ploughshare with a rotary ditcher to remove silt from the bottom of ditches aggregated to multi-task machine [3]. Ploughshare is mounted on the caterpillar frame (fig. 5). It has the ability to continuous height adjustment.



Source: own work / Źródło: opracowanie własne

Fig. 5. Scraping ploughshare with a rotary ditcher
Rys. 5. Lemiesz zgarniający z odmularką rotacyjną

Main parameters of the scraping ploughshare with rotary ditcher:

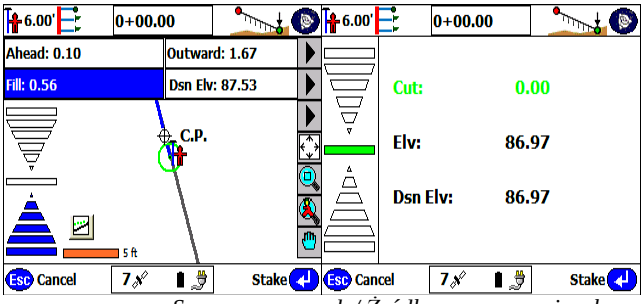
- working width: 80 cm,
- cutting height: 10-20 cm,
- the feed rate: 0,5-1,0 km/h,
- flow at rated speed: 80-100 l/min,
- hydraulic pressure: do 210 bar,
- power consumption: 28 kW,
- weight: 691 kg,
- overall dimensions with the plow (L x W x D): 397 x 132 x 135 cm.

The feed rate of ploughshare with rotary ditcher reaches a speed limits of 0,5-1,0 km/h with desilting to a depth of 20 cm, depending on the water level in watercourses and the degree of compactness of removing soil (Fig. 6).

Source: own work / Źródło: opracowanie własne

Fig. 6. Desilting watercourse using a rotary desilting machine
Rys. 6. Odmulanie cieku melioracyjnego odmularką rotacyjną

The essence of the desilting watercourses is to preserve longitudinal downslope in bottom, which guarantees an adequate water flow in canals. Most preferred longitudinal downslope in the bottom of main drainage ditches are in the range of 0.05-0.10%. The larger trenches used downslope close to 0.05% and lower trenches may be downslope close to 0.1% [4]. A controller measures height of the ploughshare based on GPS positioning system. The program compares the actual height of ploughshare to height determined during the project work and automatically corrects these values with a precision of ± 1 cm (fig. 7).



Source: own work / Źródło: opracowanie własne

Fig. 7. Software for leveling the land, based on the precise GPS measurements

Rys. 7. Oprogramowanie do niwelacji terenu, bazujące na precyzyjnym pomiarze systemem GPS

Regulated end of rotary ditch provides steady throw of silts, without additional grading. Leaving excavated material on the edge of slopes produce difficulties of surface water outflow. Dredged materials can flow back into the canals while heavy rains (Fig. 8).

Source: own work / Źródło: opracowanie własne

Fig. 8. Watercourse desilting drainage while the cutting plants on slopes

Rys. 8. Odmulanie cieku melioracyjnego z jednoczesnym wykaszaniem roślinności na skarpach

Desilting works should be performed in opposite direction to the water flow enabling to drain the water freely into watercourses and facilitating maintenance. The essence of the removal of silts and bottom sediments is to maintain correct bottom width. Widening slopes leads to damage the shape of slopes and this leads to scouring and sliding down slopes. The effects work is illustrated in fig. 9.

Source: own work / Źródło: opracowanie własne

Fig. 9. Condition of watercourse; the photo at the top shows a ditch before desilting, the photo below shows a ditch after desilting while mowing grass on slopes

Rys. 9. Stan cieku melioracyjnego; na zdjęciu powyżej pokazano stan przed odmulaniem, na zdjęciu poniżej pokazano stan po odmulaniu i jednoczesnym wykaszaniu skarp

The technology also allows the removal of silt from the bottom of watercourses using backhoe, mounted to the tiltrotator arm. Renovation of open watercourses with backhoe is used in small and dried watercourses (fig. 10).

Source: own work / Źródło: opracowanie własne

Fig. 10. Removal of silt using the bucket of multi-task machine

Rys. 10. Usuwanie namułów łyżką podsiębierną

4. Performing new open watercourses

Even though most treatments are related to drainage maintenance or renovation of existing infrastructure, there is a need to quickly implement new fertigation - drying ditches From a practical point of view, that ditches have a depth of 0.6-0.7 m. While digging new trenches it`s important to maintain correctly width bottom, which is necessary for the proper operation of the ditch. Technology digging a new ditches with depth occurs in several steps (fig. 11).

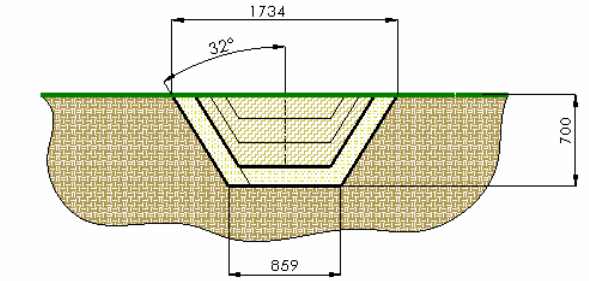


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Fig. 11. Diagram of the process of layer execution of fertigation - desiccation ditches

Rys. 11. Schemat procesu warstwowego wykonywania rowów nawadniająco osuszających

The first step involves removal of soil layer at 0.15 m using a rotary ditcher with ploughshare and automatic leveling based on precise measurements of the GPS receiver (fig. 12). Slope angle equal to 40° is controlled by cutting ploughshare.

A soil regenerator performs a process of output dredge to outside the trench left by rotary ditcher (Fig. 13). The soil regenerator, which dig on 15-20 cm depth, needs to go several times to making of a correct trench width. That tool has an adjustable ploughshare, which allows simultaneous deepened trench.

Source: own work / Źródło: opracowanie własne

Fig. 12. Performing the drainage groove by scraping ploughshare with a rotary desilting machine
Rys. 12. Wykonywanie rowka melioracyjnego odmularką rotacyjną z lemieszem

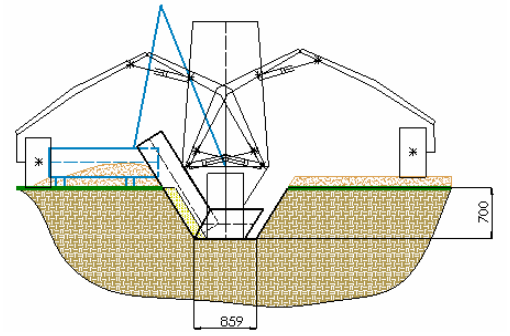

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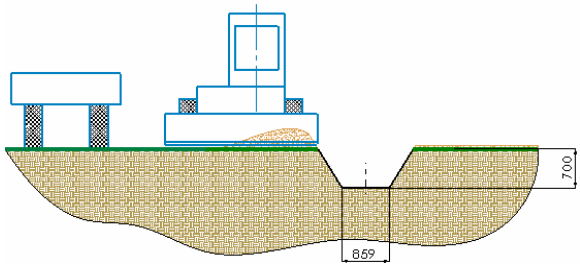
Fig. 13. Shaping the ditches using the soil regenerator
Rys. 13. Kształtowanie rowu przy zastosowaniu frezarki ślimakowej

Accordingly to the assumptions of the new watercourses project, management of excavated spoils and their distribution along the trench edge using a bulldozer or removal is necessary (fig. 14).

5. Summary and Conclusions

This article describes the process of shaping the open watercourses using new technology developed by the Industrial Institute of Agricultural Engineering. This process uses innovative tools with unique properties that allow for effective realization of the works related to removal of silt defaulting on the bottom of the ditch and allow the formation of slopes of any chosen standard.

Tools are attached to the multi-task machine arm or to the patented tiltrotor linkage. A hydraulic oil supplied with the drive system of the machine is the source of the power supply to the actuators. Devices are positioned by modern control apparatus, developed at PIMR and based on the GPS system, ensuring precision of ±1cm. The demand for power tools is approx. 30 kW, hence the task of shaping the watercourse is effective from an economic point of view.



Source: own work / Źródło: opracowanie własne

Fig. 14. The dredged materials management
Rys. 14. Zagospodarowanie urobku

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