

Constructive layout of a combined planter for complex grass mixtures

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Abstract

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The specific features, of the sowing of complex grass mixtures, require the usage of specialized planters. One of the most important features for the functionality of those machines is the creation of the working bodies for them. The aim of this article is to create and establish the technical parameters of a seed box – equipped with an arch-destroying stirrer, which would be a part of the created by us experimental combined seeder - STS-80. To be able to determine the volume of the seed box the principles of dynamic construction and engineering modeling of prefabricated technical details have been applied. The results give us the opportunity for the production of a seed box with sufficient volume for sowing two strips with a total area of 2 hectares with the EU standard width of 40 cm each. The precise parameters of the newly constructed arch-destroying stirrer, its positioning in the seed box and the way of its drive have been established. The functional capabilities of the new combined planter have been extended thanks to the parameters of its working bodies and their mutual staffing. The STS-80 can not only be used for turf sowing of decorative lands but also for the erosion grassing of terraces, slopes and headlands in agricultural areas.

Key words: planter; seed box; stirrer; parameters

Introduction

In the decorative horticulture for the grassing of agricultural grounds which are used for the production of turfs the main planter used for those procedures is the planter which is also used for the sowing of cereal cultures. The most important step for the cultivation of not only the agricultural crops but as well as the grass turfs is the sowing, which in itself has strict agro-technical requirements (Karadocheva, 2002; Demirev, 2013; Tihanov, 2019). The planters in question, however, cannot comprehensively cover agro - landscape requirements with regard to: thickness; uniformity of the sowing and the sowing of the seeds at standard poles, the reason behind this being is that the construction in itself is designed to perform regular sowing (Kruchin, 2009; Larushin et al., 2010). The points which are mentioned above undoubtedly can become a problem for the sowing of long-lasting grass mixtures, used for the creation of thick and long-lasting turf. This problem is also affected by the different size, form and the degree of smoothness of the mixture components, which are in a tense state in the hopper of the seed drills (Kaprenko & Halanski, 1989; Nosnikov & Asmolovsky, 2009; Demirev, 2013).

For the solving of the stated problem manufacturers, of sowing equipment for landscaping, are suggesting different options and improvements of the planters (Ivanov & Sijanova, 2012; Marinov, 2013). However, those options and improvements are also responsible for more complicated designs and functions of the said machines, which also indicates that their price would be relatively higher. The approach with the design of an improved seed box for a combined grass seed drill for grass mixtures (STS) complete with an active stirrer, turned out to be successful and effective.

Both of the working bodies of the machine should be compliant with the physical & mechanical properties and the technological characteristics of the most commonly used grass mixture for the soil and climatic conditions (Karadocheva, 2002; Lepkovich, 2003). Those properties and characteristics of the mixture are already stated in other of our publication and they are taken as a base for the offered constructions (Sevov & Hristova, 2015; Hristova, 2018).

The objective of the publication is to analyze the design features and establish the parameters of a seed box for complex grass mixtures and a water-destroying mixer, which are provided for the main working bodies of the combined grass seed drill STS-80.

Materials and Methods

The main objective is the construction of a seed box for the created by us combined planter – STS-80, which is constructed with the purpose of sowing complex grass mixtures. The main purpose of the seed box is to collect optimal stock of grass seeds, which should be sufficient to carry out a quality working process with a maximum possible sowing rate of 40 kg / dka and a working length of the field of 200 m. Additionally to this requirement it is necessary to take into account several other concomitant and influencing the volume factors when it comes to the design of the seed box:

1. After the conclusion of a full working cycle there should be at least 10 – 15% of remaining seed stock until the new loading of seeds;
2. The bulk density, shape and surface condition of the

seeds of the components of the grass mixture used and of it as a whole;

3. Compliance with the practical recommendation that the hopper volume of 50 to 80 dm³ per 1 m width of the seed drill grip is rational (Kaprenko & Halanski, 1989; Larushin et al., 2010).

In this case, a seed stock is accepted until a new charge of 10%. The bulk density of the seeds is determined by a threefold repeatability (permissible error ± 20 g) and is calculated with the formula:

$$\rho = \frac{m}{\bar{v}}, \quad (1)$$

Where m is the mass of the seeds in a measuring vessel, kg; \bar{v} - capacity of the vessel, m³.

Preliminary studies were performed on a laboratory experimental stand Figure 1 however the functionality of the seed box has been tested in an actual technological process.

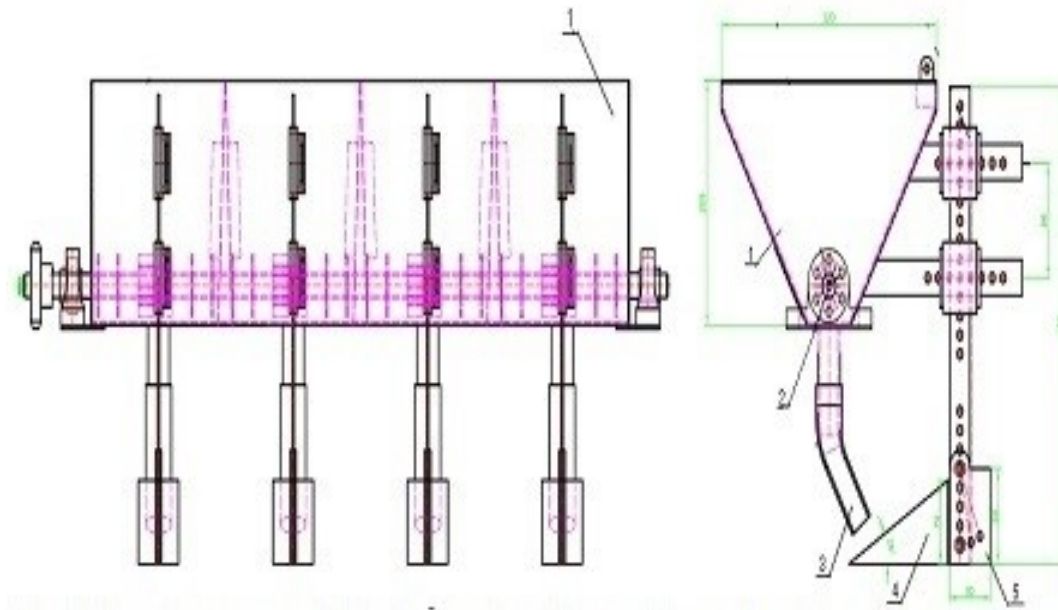


Fig. 1. Experimental stand for the testing of the seed box: 1-seed box; 2- arch-destroyer stirrer; 3-seed pipelines; 4- positioning reflector; 5-handle

The form and the surface condition of the seeds of the different components of the grass mixture have been determined in a previous work of ours (Sevov & Hristova, 2015).

In order not to keep the seeds on the walls of the seed box, the angle of their inclination must obey the inequality (Larushin et al., 2010):

$$\beta > \varphi + \gamma, \quad (2)$$

Where β is the angle of inclination of the walls to the

bottom, in degrees;

γ - angle of deviation of the walls, φ - angle of friction of the seeds on the surfaces, °.

The sizes of the openings for the leakage of the seeds from the bunker are determined in accordance of the condition of providing the best bandwidth. The form of the openings of the constructed planter is rectangular and their size is in accordance to the maximum length of the sowing wheel of the seed drill: $l_k = 33$ mm.

Results and Discussion

Constructive parameters of the seed box for the planter STS-80. Applying the already used methods, the seed box is going to be constructed using stainless steel with a thickness of $\delta = 1.5$ mm, due to the fact that with

this material the friction of the seeds presents a low coefficient of variation - $CV = 2.94\%$ (Hristova, 2018). In order to achieve the necessary volume for the ensuring the sowing rate for the entire working cycle, the seed chest is designed with trapezoidal section in its main part and with a rectangular - in the superstructure Fig. 2.

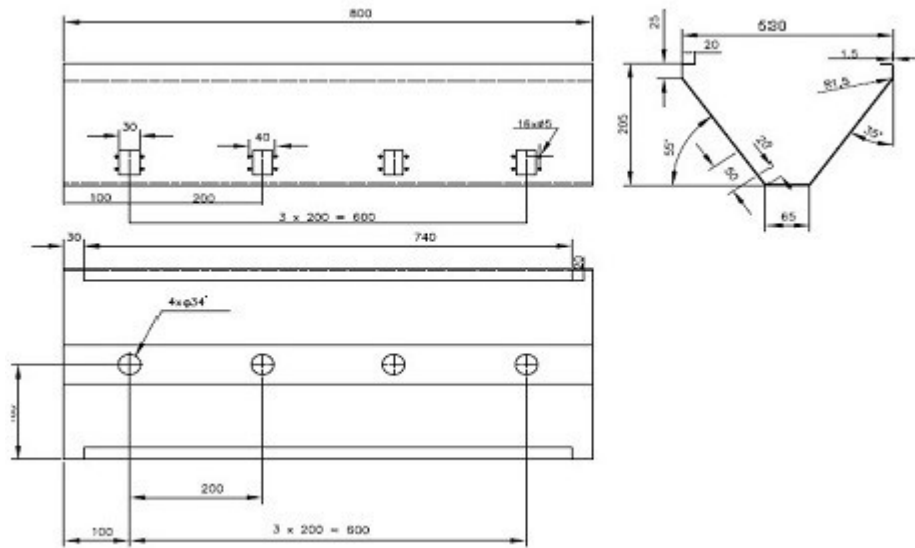


Fig. 2. Blueprint of the sides of a seed box for a combination drill

From the figure it is evident that the slope of the sides of the seed box is under a 55° angle, which is in accordance with the requirement for an equal distribution of seed flow from the openings to the metering wheels of the seed drills. The four openings are distanced at 200 mm between each other and are with optimal sizes of 30 x 50 mm, which guarantees the achieving of the maximum sowing rate of 40 kg/dka. The full volume of the seed box U , which

according to the given parameters is equal to 50 dm^3 , is determined by the sum between the volume of the rectangular part U_1 and the trapezoidal part U_2 .

Due to its specific properties it is necessary for the seed box to be equipped with a stirrer, which prevents the often occurring vaulting, typical for the mixtures of the grass types Fig. 3a.

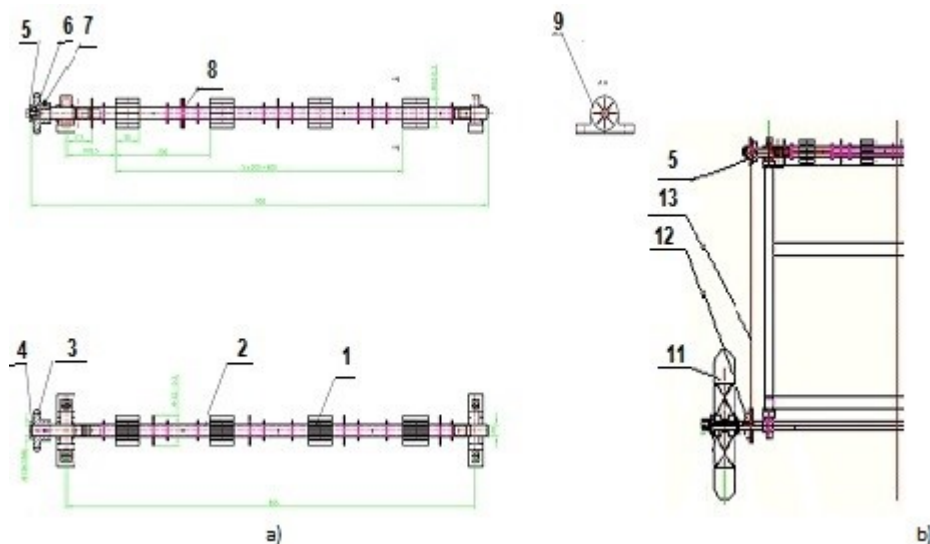


Fig. 3. Design parameters of the stirrer for the seed box

The new active stirrer is with four turbine wheels 1 placed above the openings for seed distribution and the gears 8 (with diameter of 3 mm and length of 52 mm). They should be installed on the helix of the horizontal shaft 2 in the inter-opening zone. The outgoing gudgeon 5 is made with a diameter of 22 mm and its fastening to the shaft is possible thanks to a prismatic key 6x6 / L = 20 mm.

The arch-destroying agitator is mounted on a self-

adjusting roller bearing 9 SG 56204 ($\phi 20 \times \phi 20 \times 15$) and is driven by a transmission 12 through the right in the direction of travel running wheel 11 of the grass seed drill. In such implementation of engineering solutions the number of the arches does not exceed 5% in ten working cycles and even then those arches are self-destroying themselves with the movement of the experimental planter.

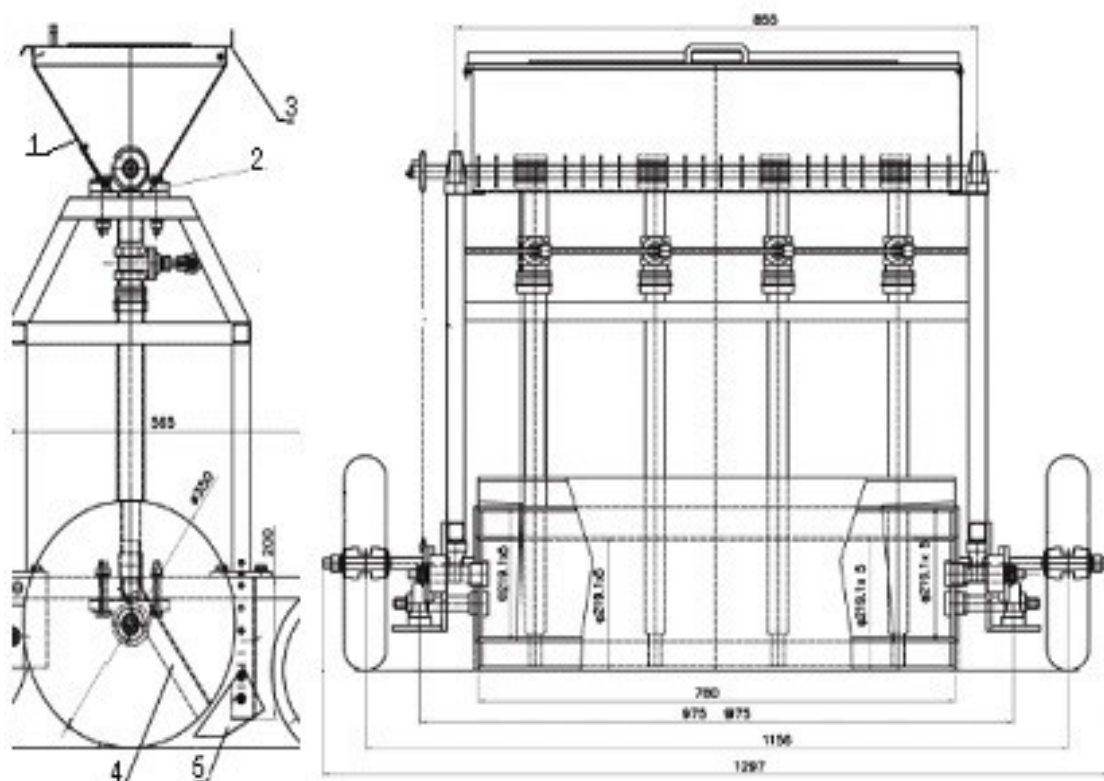


Fig. 4. Combined arrangement of seed box for planter STS-80: 1- seed box; 2- arch-destroying stirrer; 3-lid; 4- seed pipelines; 5- positioning reflector

The preliminary examinations of the seed box for STS-80 present a stable and quality flow of the workflow as well as meeting the set agro-technical requirements, which indicates that the engineering justification and technical construction of this main body of the device of seed drills for grass mixtures can be built into the specialized seeders.

Conclusions

Based on the performed design and research work for the combined seeder - STS-80, specializing in sowing complex grass mixtures two main design features were

covered: (i) Substantiated technical parameters of a seed box, its construction has been developed in accordance with the time cycle of the working process, as the volume of 50 dm^3 covers the accepted total length of the bed 400 m, leaving 10% stock of seeds; (ii) The complex dimensional characteristics of the free-breaking agitator have been established, namely: active length 800 mm and total length 958 mm, including the bearings for rotation and rotation. In addition, based on the justifications and analyzes of the developed working bodies of the complex seed drill, a projection assembly of a seed box complete with a stirrer and a lid is presented.

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