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The Methodology of Experimental Investigations of the Grain Materials Velocity from the Physical Model of the Dump Bunker

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Abstract

The article deals with the practical experience and methods of experimental studies of loose grain materials of the main crops unloading by the grain harvesting combine dump hopper. The main objective of the investigation is to minimize mechanical grain material damage, which is relevant for seed farms.

Key words: methodology, experimental investigations, combine harvester, dump hopper, grain crops, productivity

Keeping to agro-technological requirements to the quality of accumulation of harvested material and its unloading into vehicles by harvesting machines and combines continue to be a rather complicated scientific-technical problem. Unresolved problems still remain, as to consequences: unloading devices complex design; insufficient stability of unloading material process from bunkers-storage; low productivity of grain-vegetable material with different physical and mechanical properties unloading (Adamchuk *et al.*, 2004; Pogorilets, Zhyvolup, 2003; Voyityuk *et al.*, 2005); significant time (up to 15%) spent on unloading bunkers-drives (Bondar, Shymko, 2017; Loveyikin, Nedovesov, Shymko, 2016); essential damage of grain and plant material, etc. (Pekhalskiy, Artushin, Elizarov, Slavkin, Sorochinskiy, 2016; Chausov, Bondar, Shymko, Pylypenko, 2013). The development of more advanced structures of harvesting machines and combines, without deficiencies, is impossible without theoretical basis of working processes rational parameters and engineering calculation of unloading devices (Loveyikin, Nedovesov, Chovnyuk, Shymko, 2012).

The experimental research of different materials velocity according to their mechanical and technological properties of grain materials, from the physical model of the dump bunker, have the purpose to trace the trajectory and determine the speed of movement of separate grains during the working process of collected

material transportation by the method of gravitational stream. These data are necessary for assessing the adequacy of the analytical models of the grain mixture in optimization problems of the dump bunker kinematic parameters. In accordance with this, the series of experiments is expected to determine the dependence of the unloaded experimental grain material movement speed from the calculated time of emptying (angular velocity of rotation) of the dump bunker.

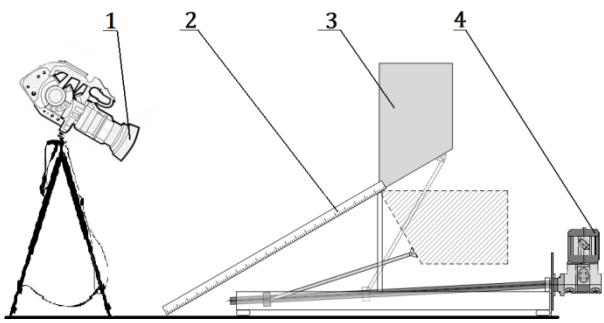
The following equipment and materials were used for realization of experiments: experimental installation of a dump bunker physical model with a special (with marked ground) tray 1200 mm of length; digital camcorder Canon HV 30; personal computer; variable capacities for grain material; electronic moisture meter Wile 55; investigated grain material of the main crops.

The establishment of grain material rate movement indicators occurred in the following sequence: according to the scheme, shown in Fig.1, the equipment was installed on a level solid surface.

On a standard tripod, the Canon HV 30 camcorder was fixed with the help of a viewfinder, in accordance with the operating instructions, expressive reflection of the extended tray sliding surface of the experimental setup of dump bunker physical model.

Adjustment of the variable screw speed, the mechanism of hopper rotation was tuned at an angular speed of 0,05 radians / second.

The studied grain material was dropped into the dump hopper of the experimental plant. The hopper was placed in a horizontal position by regulated mechanism and using the water-level. On the surface of the grain material were placed pre-painted in different contrasting colors (red, orange, blue, green and white) separate grains of the studied material.



1 – the digital camcorder Canon HV 30;
2 – the hopper tray extender with corresponding markup;
3 – the physical model of dump bunker;
4 – the rotation mechanism of the hopper with a variation of speed.

Fig. 1. General scheme of installation for experimental studies of the gravitational leakage velocity of grain material from the physical model of the dump bunker

Transferring the camcorder from “Stand-by” mode to the operating mode of recording the image (on the monitor of the camcorder, according to its functions, real-time recording was performed and the sound was recorded together with the

video). Output data of the research – the culture (grain material), the rotation speed of the lifting screw, the repetition of the experiment – were reported loudly. The drive of the lifting screw was activated (when documenting of video recordings was made, the beginning of the sound of the drive mechanism served as a sign of fixing the beginning of the reference time of the experimental bunker rotation to the vertical position).

Then, a continuous, rapid gravitational flux of investigated grain material was observed in the capacity, while the video camera fixed the gravitational movement of the grain shifting surface, including the movement of the correspondingly colored grains relatively to the marking of the elongated tray. As soon as the hopper reached the vertical position, the drive was firstly turned off the lifting screw, and stopped recording of the camcorder. After completing the next repetition of the experiment, the equipment was brought to its original state.

Filmed footage, according to the standard procedure, was transmitted for further documentation to a personal computer. Frame-by-frame image of the slipstream was received by using the corresponding software "Pinnacle Studio 12". The position of the painted grains relative to marking of the elongated tray was studied on separate, sequential images and the values of their displacements relative to the selected marker beacons with the documentation of the real time of each frame from the video were fixed. Thus, the documentation of the obtained experimental data in the form of Table 1 was carried out.

Table 1. Form and example of documentation of data on the velocity of gravitational leakage of grain materials from a dump bunker

Repeat experiment: № 3;				**Grain material: Winter wheat**	
The Color of grain	Image number	Time indicator of the grain output to the zero mark of the marker beacons from the beginning of the turn– t_i^0, sec.	Image number	Time indicator of the grain output to the finish mark of the marker beacons from the beginning of the turn – t_i^{ϕ}, sec.	The velocity of the grain is displaced by the surface – v_i, м/sec.
red	38359	11,4	38441	27,8	0,061
orange	38355	10,6	38448	29,0	0,054
blue	38365	12,6	38458	31,2	0,054
green	38356	10,8	38445	28,6	0,056
white	38362	12,0	38436	26,8	0,067

The systematized experimental data was processed and tested according to the standard method of statistical randomization and independent testing of the results using the Microsoft Excel 2014 Analysis package. The mean square deviation and coefficient of variation of the measured values were also calculated.

Conclusion

The experimental research peculiarity of the working processes of the unloading devices of harvesting machines is that the mechanized technological process of grain and vegetable material leakage from bunkers-drives into vehicles, above all, depends on the parameters and operating modes of the unloading devices. Nevertheless, the scientific justification is impossible without a detailed study of the mechanical and technological properties of agricultural materials, the motion laws of friable bodies and the peculiarities of technological processes and operations associated with the accumulation and overload of grain and vegetable material from a dump bunker (Loveyikin *et al.*, 2012).

In connection with this, the program and the methodology of experimental research provided three stages, which include the joint common goal, individual researches, the implementation of which provides the verification and, if it is necessary, the correction of theoretical positions, considerations and conclusions to improve the efficiency of the production process harvesting at expense of reasonable parameters and operating modes of unloading devices of harvesting machines.

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