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Slope And Length Of The Feed Chute

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Abstract.

The main purpose of the research is to determine the slope and length of the feed distributor discharge chute in small livestock farms. A mini roughage spreader is proposed for farmer (personal assistant) and small animal husbandry. The structure and working process of the mini distribution device are presented. When determining the slope and length of the spillway, the coefficient of friction of the feed on flat surfaces was taken into account. Based on the equation of motion of the ground coarse feed, mathematical expressions were obtained to determine the slope angle, length of the discharge chute. According to the results of theoretical studies, the slope of the spillway should be greater than 290, and the length should be between 0.273 m and 0.315 m.

1. Introduction.

Research on the creation of vertical and horizontal type feed distributors that grind coarse feed and distribute it by mixing, and on the basis of the constructions and parameters of their working bodies Rittinger, Rebinder, V.L. Kiripichev, M.M. Gernet, V.A. Goransky, S.M. Melnikov, N.E. Reznik, V.I. Perednaya, S.I. Nazarov, W.J. Chancellor, M.J. Odogherty, G.E. Gale, P. Singh, Y. Jekendra, V.G. Malkov, T. Abiljanov, J.C.E. Quist, S. Kwofie, P. Toneva, I.M. Kupchuk, M.I. Dabbour, D. Dziki, F. Zhu, J. Zhao, F.M. Mamatov, K. D. Astanakulov, Dj. Alijanov and others. These studies were mainly carried out on high-performance forage spreaders designed for large farms. The main purpose of the research is to determine the slope and length of the mini feed spreader intended for small livestock farms [1-10].

2. Materials and methods

Based on the design and technological work process of coarse fodder spreading machines, the research conducted on their research and the study of the compositional structure of coarse fodder, a coarse fodder distribution device with a compact version of a light construction was developed for the farmer (personal assistant) and small livestock farms (Fig. 1).

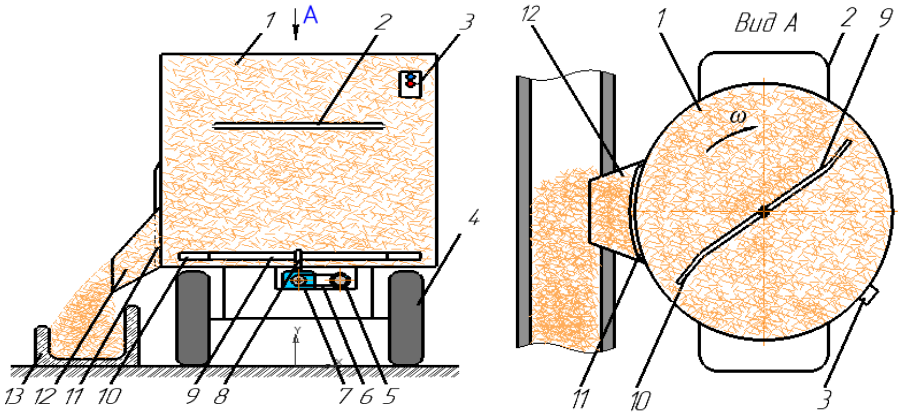

Figure 1. Scheme of the coarse feed distribution device: 1-bunker; 2- handle; 3-start button; 4-wheels; 5-mover; 6-belt drive; 7-worm reducer; 8- rotor; 9-spade; The tip of the 10-blade is oblique; 11 and 12 - pouring window and trough; 13- manger

The working process of the coarse feed distribution device is as follows. The fodder is loaded into the hopper 1 and, holding the handle 2, the feed spreader is moved by the wheels 4 and taken to the feed distribution place, and the mover 5 is started by the start button 3. At the same time, the movement is transmitted from the drive 5 to the worm gear 7 through the belt transmission 6. In turn, the worm reducer 7 transmits the movement to the rotor 8, reducing the number of revolutions several times. Blades 9 are installed on the shaft of the rotor 8, and at the same time, the blades 9 rotate together with the shaft of the rotor 8. As a result of the rotation of the blades 9, the feed begins to move from the center of the hopper 1 towards the tip 10 of the blades. At the same time, the feed moves rapidly along the blades 9 to the inclined tip 10 of the blades and starts to leave the discharge window 11. The feed from the discharge window 11 falls into the manger through the discharge chute 12. The inclined location of the tip 10 of the shovels 9 simultaneously improves the pushing and ejecting of feed by the shovels [9-11]. When distributing coarse feed, their spillage in the required amount is regulated by the efficiency of the feed spreader shovels, their rotation speed and the ratio of the feed spreader's movement speed.

3. Results and discussion

In order for the crushed coarse feed from the discharge window of the feed distributor hopper to move under the influence of its own gravity G on the discharge chute, the chute should have a certain slope. We determine the slope of the discharge chute δ from the equation of motion of the crushed coarse feed

$$m\ddot{x} = G\sin\delta - F_{ishq}, \quad (1)$$

here F_{ishq} is the force of friction.

Given that $F_{ishq} = fN$ is $N = G\cos\delta$, we can write expression (1) as

$$m\ddot{x} = G\sin\delta - fG\cos\delta. \quad (2)$$

The analysis of the expression (2) shows that the following condition must be met in order for the crushed coarse feed to move freely on the discharge chute and spill onto the ground, that is, the component of the gravity force along the surface of the chute must be greater than the friction force [12-14]:

$$G\sin\delta > fG\cos\delta. \quad (3)$$

(3) if we reduce the expression to G, this expression will have the following form:

$$\sin\delta > f\cos\delta. \quad (4)$$

(4) expression can be written as follows:

$$\frac{\sin\delta}{\cos\delta} > f \quad . \qquad (5)$$

Since $\frac{\sin\delta}{\cos\delta} = tg\delta$ and $f = tg\varphi_{ishq}$ in expression (5), this expression is as follows:

$$tg\delta > tg\phi_{ishq}$$

or

$$\delta > \phi_{ishq} \quad . \qquad (6)$$

According to this condition, the slope of the discharge chute δ should be greater than the angle of friction of the feed on the chute φ_{ishq} so that the crushed coarse feed moves freely on the chute and spills onto the ground. If we take into account the friction angle of the crushed coarse feed according to the results of the experiment, then we can find out that the slope of the feed distributor discharge chute should be $\delta > 29^0$. A pile of coarse feed spilled on the ground is vertical and has a triangular cross-section in the plane perpendicular to the direction of the device. This triangle is denoted by ABC in Figure 2.

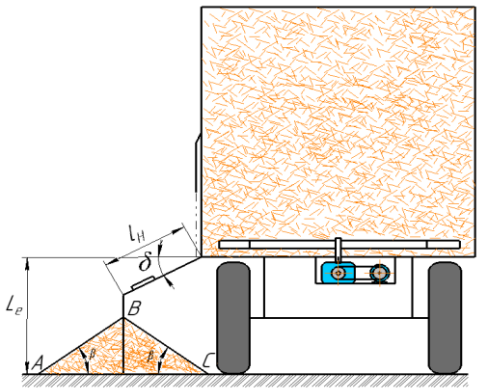

Figure 2. Schematic diagram of a spillway and a pile of feed spilled on the ground

Pile dimensions, namely height BD and width AC, amount of distributed mass q and volumetric weight of unpressed (empty) roughage ρ_b and natural slope angle β depend on it. To find this relation, we use the following expression:

$$q = \frac{1}{2} BD \cdot AC \cdot \rho_b \quad . \qquad (7)$$

Since $BD = DC \cdot tg\beta$ and $AC = 2DC$ in expression (7).

$$q = DC^2 tg\beta \cdot \rho_b \quad . \qquad (8)$$

As a result, the pile height and width are found:

$$DC = \sqrt{\frac{q}{tg\beta \cdot \rho_b}} \quad , \qquad (9)$$

$$BD = \sqrt{\frac{q \cdot tg\beta}{\rho_b}} \quad , \qquad (10)$$

$$AC = 2\sqrt{\frac{q}{tg\beta \cdot \rho_b}} \quad . \qquad (11)$$

The pile must be completely outside the hopper channel, so the following condition must be met:

$$DC < l_н \cos\delta, \quad (12)$$

here $l_н$ – the length of the spillway.

From expressions (9) and (12), we determine the length of the drain pipe:

$$l_н > \frac{1}{\cos\delta}\sqrt{\frac{q}{tg\beta \cdot \rho_b}}. \quad (13)$$

In addition, the bottom of the trough should be higher than the top of the pile, that is:

$$BD < L_e - l_н \sin\delta. \quad (14)$$

From expressions (10) and (14), we define an additional condition for the length of the drain line:

$$l_н < \frac{1}{\sin\delta}\left(L_e - \sqrt{\frac{q \cdot tg\beta}{\rho_b}}\right). \quad (15)$$

If $q = 5kg/m$; $\delta = 35^0$; $L_e = 0{,}5m$; $\beta = 55^0$; $\rho_b = 70kg/m^3$, the following conditions must be met for the length of the drain pipe: $l_н > 0{,}273m$ and $l_н < 0{,}315m$.

4. Conclusions

A mini coarse feed spreader is offered. It was found that the slope and length of the spreader chute are affected by the coefficient of friction of the feed on flat surfaces. Based on the equation of motion of the ground coarse feed, mathematical expressions were obtained to determine the slope angle and length of the discharge chute. According to the results of theoretical studies, the slope of the spillway should be greater than 290 and the length should be between 0.273 m and 0.315 m.

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