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THE INFLUENCE OF TECHNOLOGICAL PARAMETERS OF THE ELEVATOR ON COTTON SEED DAMAGE

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Abstract: The article theoretically analyzes the forces affecting the seed flow during transportation of cotton seeds by bucket elevators. It also analyzes the influence of technological parameters on seed damage. The theoretical studies show that the impact of seeds ejected from the elevator buckets on the proposed belt conveyors has led to a decrease in seed damage. It has also been established that seed damage depends on the roughness of the striking surface and the speed of the belt, and rational parameters for the studied elevator are recommended.

Keywords: elevator, bucket, conveyor, drive, seeds, damage, belt drive, trajectory, speed, rigidity.

Introduction. It is known that in the internal and interdepartmental flow system for transporting cotton and cotton products, continuous mechanical and air transport means are widely used.

In the cotton cleaning industry, as well as in other sectors, various types of equipment are used for transporting finished products and semi-finished goods produced in the industry, as well as fruits and vegetables grown in agriculture. For example, conveyors and elevators are used for transporting agricultural products, grain, potatoes, sunflower seeds, cotton, and other types of products within and between workshops. These have different designs depending on their characteristics. At cotton processing enterprises, elevators with various working components and other types of equipment of varying lengths and angles of inclination are used to transfer cotton and seeds to technological machines.

Continuous mechanical conveyors include elevators, belt conveyors, and screw conveyors, which are mainly used for transporting cotton, seeds, lint, fibrous waste, and debris. Screw (auger) conveyors are used for transporting cotton and seeds and distributing them to cotton cleaning plants, lint cleaners, cotton cleaning units, and other equipment suppliers. Mechanical continuous transport means include elevators, belt conveyors, and screw conveyors, which are primarily used for transporting cotton, seeds, lint, fibrous waste, and impurities. [1].

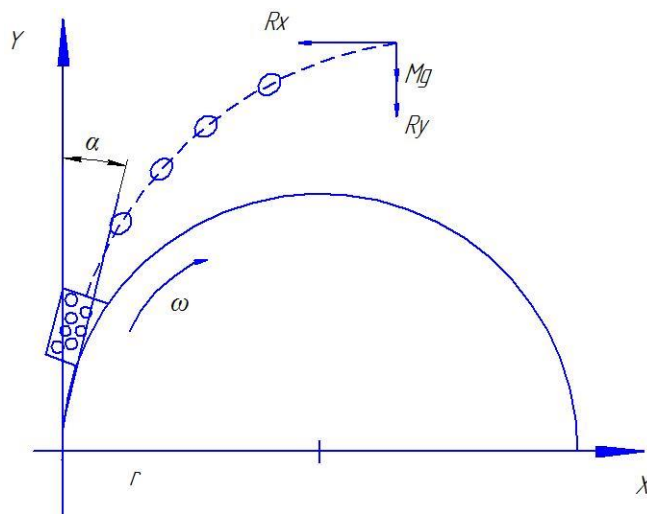
The cotton auger of the SHK type is designed for transporting cotton in a horizontal position and feeding it into the gin feed chute, cotton cleaner, and other machines. Elevators of the EKC type are used for vertical transportation of cotton, seeds, and waste at cotton processing plants. The EKC-15M1 elevator is used for transporting cotton, the ES-14M seed elevator, and the ES-14C elevator for waste are designed for transporting seeds and waste [1].

In order to prevent and reduce the damage to raw cotton and seeds, it was suggested that the seeds ejected from the elevator bucket should fall onto a belt conveyor rather than onto a metal surface [2, 3, 4].

The article establishes that the resistance of conveyor belts to tensile and weight forces, achieved by enhancing the strength of the connected or cross sections and bonding, allows for a reduction in downtime for repairs by up to 7% [5].

A new design of belt conveyors was developed by installing roller equipment in the receiving and transferring units of cotton [6, 7].

Theoretically, we will analyze the influence of the seed flow on the transfer of the seed flow under the impact of a bucket conveyor, depending on the mass of the seeds in the bucket, that is, its volume (pic. 1).



Pic. 1. Schematic diagram of seed flow on a bucket conveyor.

Let's derive the general differential equation of motion for the seeds being transported on the bucket:

$$\begin{aligned} M \cdot \ddot{x} &= -R_x \cdot \vartheta_x \\ M \cdot \ddot{y} &= -R_y \cdot \vartheta_y - M \cdot g \end{aligned} \quad (1)$$

where R - the force of air resistance, H.

$$R = k \cdot M \cdot g \cdot \vartheta \quad (2)$$

where k - the coefficient of resistance; g - the acceleration due to gravity, m/s^2 .

Let's determine the trajectories of the seed flow movement process when it detaches from the bucket under the influence of external forces.

By integrating the differential equation (1), we can determine the equations of motion for the seeds along the OX and OY axes:

$$\begin{aligned} M \cdot \ddot{x} &= -k \cdot M \cdot g \cdot \dot{x} \\ M \cdot \ddot{y} &= -k \cdot M \cdot g \cdot \dot{y} - M \cdot g \end{aligned} \quad (3)$$

From the differential equation (3), we obtain:

$$\begin{aligned}\frac{d\vartheta_x}{dt} &= -k \cdot g \cdot \vartheta_x \\ \frac{d\vartheta_y}{dt} &= -k \cdot g \cdot \left(\vartheta_y + \frac{1}{k}\right)\end{aligned}\quad (4)$$

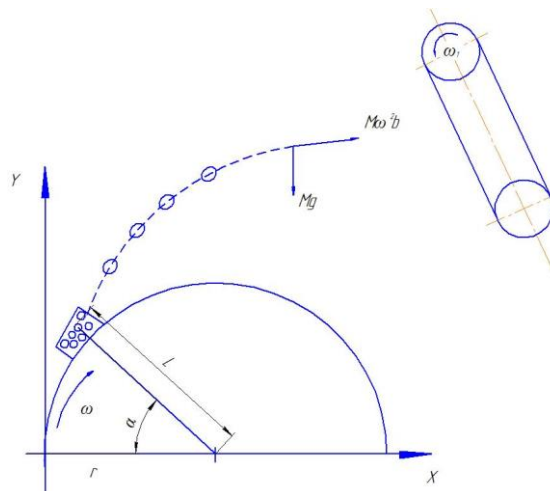
We will integrate the differential equation (4) once with respect to time and determine the velocities of the seed flow transferred by the bucket:

$$\begin{aligned}\frac{d\vartheta_x}{\vartheta_x} &= -k \cdot g \cdot dt & \ln \vartheta_x &= -k \cdot g \cdot t + C_1 \\ \frac{d\vartheta_y}{\vartheta_y + \frac{1}{k}} &= -k \cdot g \cdot dt & \ln\left(\vartheta_y + \frac{1}{k}\right) &= -k \cdot g \cdot t + C_2\end{aligned}\quad \text{from where} \quad (5)$$

After some transformations of the obtained equations, we will formulate the trajectory equations for the movement of the seed flow transferred from the bucket elevator:

$$\begin{aligned}\frac{dx}{dt} &= \vartheta_0 \cdot \cos \alpha \cdot e^{-k \cdot g \cdot t} \\ \Rightarrow \\ \frac{dy}{dt} &= \left(\vartheta_0 \cdot \sin \alpha + \frac{1}{k}\right) \cdot e^{-k \cdot g \cdot t} - \frac{1}{k} \\ X &= \frac{\vartheta_0 \cdot \cos \alpha}{k \cdot g} \cdot e^{-k \cdot g \cdot t} + C_3 \\ Y &= \left(\vartheta_0 \cdot \sin \alpha + \frac{1}{k}\right) \cdot \left(-\frac{1}{k \cdot g}\right) \cdot e^{-k \cdot g \cdot t} - \frac{1}{k} \cdot t + C_4\end{aligned}\quad (6)$$

We will analyze the determination of the force exerted during the transfer of the seed flow from the bucket elevator to the vibrating belt, thus reducing seed damage (pic. 2).



Pic. 2. Diagram of the seed flow movement during transfer to the vibrating belt under the influence of the bucket elevator

In this case, we determine the movement of the seeds under the influence of external forces that arise when they are ejected from the bucket.

$$J \cdot \ddot{\alpha} = -M \cdot \omega^2 \cdot L^2 + M \cdot g \cdot \cos \alpha$$

$$\frac{M \cdot L^2}{2} \cdot \ddot{\alpha} = -M \cdot \omega^2 \cdot L^2 + M \cdot g \cdot \cos \alpha \quad (7)$$

The differential equation (7) will be simplified:

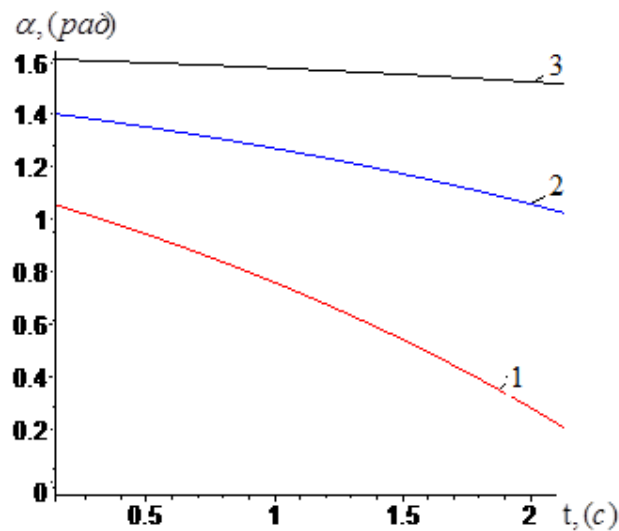
$$\ddot{\alpha} = \frac{2 \cdot g}{L^2} \cdot \cos \alpha - 2 \cdot \omega^2 \quad (8)$$

Assuming $\cos \alpha \approx \alpha$, we will rewrite equation (8) in the following form:

$$\ddot{\alpha} - \frac{2 \cdot g}{L^2} \cdot \alpha = -2 \cdot \omega^2 \quad (9)$$

After some transformations of the above equations, we obtain the equation of motion for the seed flow from the bucket elevator under the influence of external forces.

A graph of the dependence of the seed flow movement on time from the angle of elevator coverage by the vibrating belt, for different values of seed mass. $M_1 = 18 \text{ gr}$ $M_2 = 14 \text{ gr}$ $M_3 = 10 \text{ gr}$ is shown in pic. 3.



Pic. 3. Graph of the dependence of the seed flow movement on time from the angle of elevator coverage by the vibrating belt, for different values of seed mass.

$$M_1 = 18 \text{ gr} \quad M_2 = 14 \text{ gr} \quad M_3 = 10 \text{ gr}$$

As seen from the literature review and the theoretical studies conducted above, the impact of seeds ejected from the elevator buckets onto the belt conveyor results in a reduction in seed damage.

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CONTENTS

TECHNICAL SCIENCES: COTTON, TEXTILE AND LIGHT INDUSTRY

Rakhimov R., Sultonov M.	3
Inspection of the strength of the column lattice of the improved fiber cleaner	
Turdiyev B., Rosulov R.	10
The influence of technological parameters of the elevator on cotton seed damage	
Khuramova Kh.	15
Graphic analysis of the obtained results on cotton regeneration	
Sharifbayev R.	20
Optimizing feature extraction in Ai-based cocoon classification: a hybrid approach for enhanced silk quality	
Akramov A., Khodzhiev M.	24
The current state and challenges of the global textile industry: key directions for the development of Uzbekistan's textile sector	

TECHNICAL SCIENCES: AGRICULTURE AND FOOD TECHNOLOGIES

Sattarov K., Jankurazov A., Tukhtamyshova G.	30
Study of food additives on bread quality	
Madaminova Z., Khamdamov A., Xudayberdiyev A.	37
Determination of amygdalin content in peach oil obtained by pressing method	
Kobilov N., Dodayev K.	43
Food safety and industrial importance of corn starch. the impact of the hydration process on the starch content in the grain	
Mustafaev O., Ravshanov S., Dzhakhangirova G., Kanoatov X.	50
The effect of storing wheat grain in open warehouses on the "aging" process of bread products	
Erkayeva N., Ahmedov A.	58
Industrial trials of the refining technology for long-term stored sunflower oil	
Boynazarova Y., Farmonov J.	64
Microscopic investigations on the effect of temperature on onion seed cell degradation	
Rasulova M., Xamdamov A.	79
Theoretical analysis of distillators used in the distillation of vegetable oil miscella	

CHEMICAL SCIENCES

Ergashev O., Bazarbaev M., Juraeva Z., Bakhronov H., Kokharov M., Mamadaliyev U.	84
Isotherm of ammonia adsorption on zeolite CaA (MSS-622)	
Ergashev O., Bakhronov H., Sobirjonova S., Kokharov M., Mamadaliyev U.	93
Differential heat of ammonia adsorption and adsorption mechanism in Ca ₄ Na ₄ A zeolite	
Boymirzaev A., Erniyazova I.	101
Recent advances in the synthesis and characterisation of methylated chitosan derivatives	
Kalbaev A., Mamataliyev N., Abdikamalova A., Ochilov A., Masharipova M.	106
Adsorption and kinetics of methylene blue on modified laponite	
Ibragimov T., Tolipov F., Talipova X.	114
Studies of adsorption, kinetics and thermodynamics of heavy metall ions on clay adsorbents	
Muratova M.	123
Method for producing a fire retardant agent with nitric acid solutions of various concentrations	
Shavkatova D.	132
Preparation of sulphur concrete using modified sulphur and melamine	
Umarov Sh., Ismailov R.	139
Analysis of hydroxybenzene-methanal oligomers using ¹ H nmr spectroscopy methods	
Vokkosov Z.	148
Studying the role and mechanism of microorganisms in the production of microbiological fertilizers	
Mukhammadjonov M., Rakhmatkarieva F., Oydinov M.	153
The physical-chemical analysis of KA zeolite obtained from local kaolin	
Shermatov A., Sherkuziev D.	160
Study of the decomposition process of local phosphorites using industrial waste sulfuric acid	
Khudayberdiev N., Ergashev O.	168
Study of the main characteristics of polystyrene and phenol-formaldehyde resin waste	

TECHNICAL SCIENCES: MECHANICS AND MECHANICAL ENGINEERING

Kudratov Sh.	
UZTE16M locomotive oil system and requirements for diesel locomotive reliability and operating conditions	174
Dadakhanov N.	181
Device studying the wear process of different materials	
Dadakhanov N., Karimov R.	189
Investigation of irregularity of yarn produced in an improved drawn tool	
Mirzaumidov A., Azizov J., Siddiqov A.	196
Static analysis of the spindle shaft with a split cylinder	
Mirjalolzoda B., Umarov A., Akbaraliyev A., Abduvakhidov M.	203
Static calculation of the saw blade of the saw gin	
Obidov A., Mirzaumidov A., Abdurasulov A.	208
A study of critical speed of linter shaft rotation and resonance phenomenon	
Khakimov B., Abdurakhmanov O.	217
Monitoring the effectiveness of the quality management system in manufacturing enterprises	
Bayboboev N., Muminov A.	232
Analysis of the indicators of the average speed of units for the process of loading into a potato harvesting machine	
Kayumov U., Kakhkharov O., Pardaeva Sh.	237
Analysis of factors influencing the increased consumption of diesel fuel by belaz dump trucks in a quarry	
Abdurahmonov J.	244
Theoretical study of the effect of a brushed drum shaft on the efficiency of flush separation	
Ishnazarov O., Otabayev B., Kurvonboyev B.	250
Modern methods of smooth starting of asynchronous motors: their technologies and industrial applications	
Kadirov K., Toxtashev A.	263
The influence of the cost of electricity production on the formation of tariffs	
Azambayev M.	271
An innovative approach to cleaning cotton linters	
Abdullayev R.	277
Theoretical substantiation of the pneumomechanics of the Czech gin for the separation of fiber from seeds	
Siddikov I., A'zamov S.	282
Study of power balance of small power asynchronous motor	

Obidov A., Mirzaakhmedova D., Ibrohimov I.	288
Theoretical research of a heavy pollutant cleaning device	
Xudayberdiyeva D., Obidov A.	294
Reactive power compensation and energy waste reduction during start-up of the electric motor of uxk cotton cleaning device	
Jumaniyazov K., Sarbarov X.	302
Analysis of the movement of cotton seeds under the influence of a screw conveyor	
Abdusalomova N., Muradov R.	310
Analysis of the device design for discharging heavy mixtures from the sedimentation chamber	
Ikromov M., Shomurodov S., Boborajabov B., Mamayev Sh., Nigmatova D.	318
Study of obtaining an organomineral modifier from local raw materials to improve the operational properties of bitumen	
Ikromov M., Shomurodov S., Boborajabov B., Mamayev Sh., Nigmatova D.	324
Development of composition and production technology for polymer-bitumen mixtures for automobile roads	
Muradov R., Mirzaakbarov A.	332
Effective ways to separate fibers suitable for spinning from waste material	

ADVANCED PEDAGOGICAL TECHNOLOGIES IN EDUCATION

Xoliddinov I., Begmatova M.	336
A method of load balancing based on fuzzy logic in low-voltage networks with solar panel integration	
Murodov R., Kuchqarov A., Boynazarov B., Uzbekov M.	345
Research on the efficiency of using hydro turbines in pumping mode and for electricity generation	
Abdurakhimova M., Romanov J., Masharipov Sh.	353
A literature review of settlement land trends (past, present, and future) based on english-language articles indexed in the web of science database from 2014 to 2023	
Muhammedova M.	360
Development and scientific justification of the design of orthopedical footwear for patients with injuries to the soul-foot joint	
Akbaraliyev M., Egamberdiyev A.	367
Methods of effective organization of fire and rescue operations	

A'zamxonov O., Egamberdiyev A.

Principles of organizing material and technical support in emergency situations **373**

Tuychibayeva G., Kukibayeva M.

The module of developing communicative competence of seventh and eighth-grade students in uzbekistan secondary schools **379**

Ismoilova Z.

Methods for enhancing the competence of future english teachers **383**

ECONOMICAL SCIENCES

Yuldashev K., Makhamadaliev B.

The role of small business entities in the program "From poverty to well-being" **389**

Mirzakhlikov B.

Organizational mechanism for the development of state programs for poverty reduction **397**

Rustamova S.

Specific characteristics of administration in developed countries **402**
