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Determining the Safe Working Height of an Power Shovel for the Development of Iron-Bearing Tailing Dumps

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Abstract: Up-to-date large scales of ore mining and processing production cause global disturbances of balanced geochemical relation established the centuries. In return, storage of mining and concentration productions wastes are the potential source of mineral deposits. Huge amount of useful deposits which is of great value for the restoration of the raw minerals complex are contained in the waste of mining production. The development of industrial waste is accompanied with complex mining and hydro geological conditions. In this connection the task of studying the stability of the slope and selecting the optimal working height of back-acting power shovel located at the upper site is considered in this paper.

Key words: 3D Modeling · Tailings · Power shovel · Algorithm

INTRODUCTION

Nowadays the thickness of tailings dumped in iron-bearing tailing dumps is up to 40 m and above. The development of iron-bearing tailings with using a forward-acting power shovel means high energy consumption for its installation on the surface of the tailing dump [1]. However, unexpected caving of benches takes place in water-saturated stale iron tailings even if the height of benches is lower than 10 m [2]. In such situations the power shovels could not move to safe distance and the working equipment and crawler truck were piled with tailings. It caused to long shut-downs due to the complexity works of the consequences of piling [3]. That's why the application of forward-acting power shovels for the development of iron-bearing tailing dumps is not reasonable.

MATERIALS AND METHODS

The Method of Complex Research: three-dimensional parametric modeling, analysis of the results of research using specialized software systems and mathematical analysis.

Key Part: The occurrence of the positive-displacement power drive let to create new schemes of the operating equipment of the excavating machine which look like a mechanical arm rather than a mechanical spade. Possibilities of power shovels have been extended greatly. The excavating and loading equipment is installed at the upper site which eliminates the need of taking additional measures for increasing its stability on the surface; however this does not solve the problem of landslides. Based on this facts the computer-aided simulation was performed which reflected the processes during mining operations in the gravel face (Fig. 1).

In this connection the task of studying the stability of the slope and selecting the optimal working height of back-acting power shovel located at the upper site is considered in this paper.

There are various methods of modeling the slip planes; they are time-consuming and are not always reliable. The method mostly applicable for solving this task is the method introduced by professor G.L. Fisenko and based on plotting the slip curve with the application of the theory of granular media which is widely used for studying the slopes of benches formed by soft formations.

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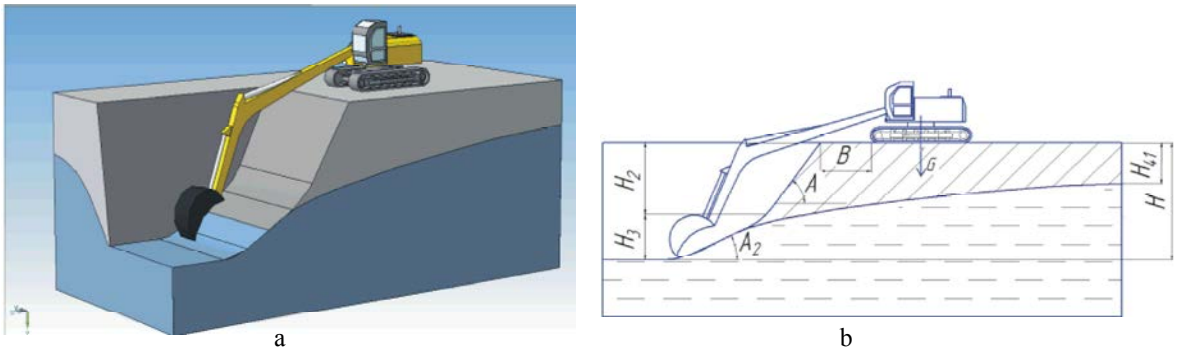

a b

Fig. 1: Computer-aided simulation of processes taking place in the gravel face during the operation of the back-acting power shovel:
a - 3D model; b - 2D model; H- safe height of the bench, m; H_2- height of upper bench, m; H_3- height of tailings debris, m; H_{41}- depth of tailings watercut, m; A- slope angle of upper bench, deg; A_2- slope angle of tailings debris, deg; B - width of safety berm, m; G - weight of excavation and loading equipment, t.

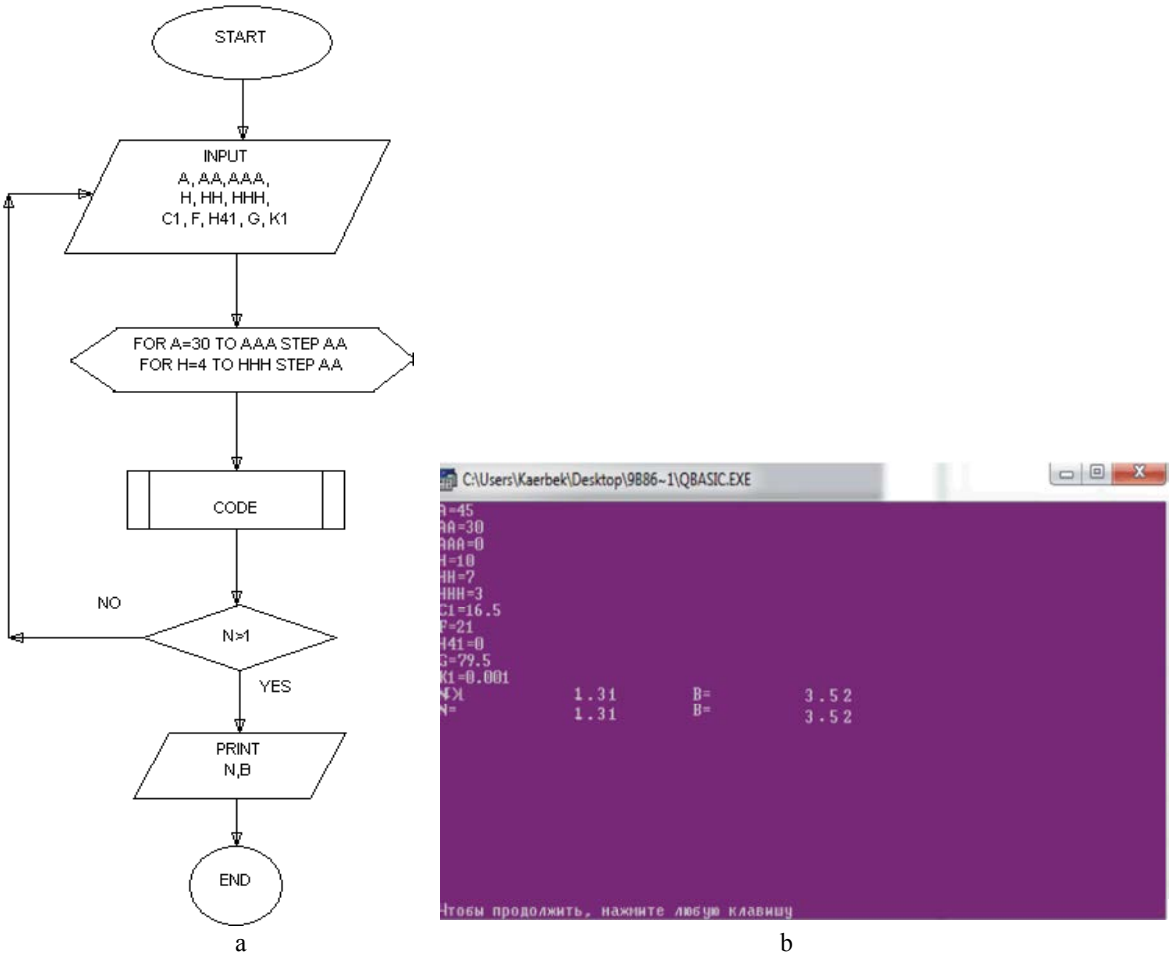

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Fig. 2: The program in Qbasic
a - flow graph algorithm; b - data input/output window.
K 1- permeability, m/day; F - slope of repose, deg; C1 - tailings adhesion, kPa; $H,H_2,H_3 = H,HH,HHH$, m; $A,A_2 = A,AA$ deg.

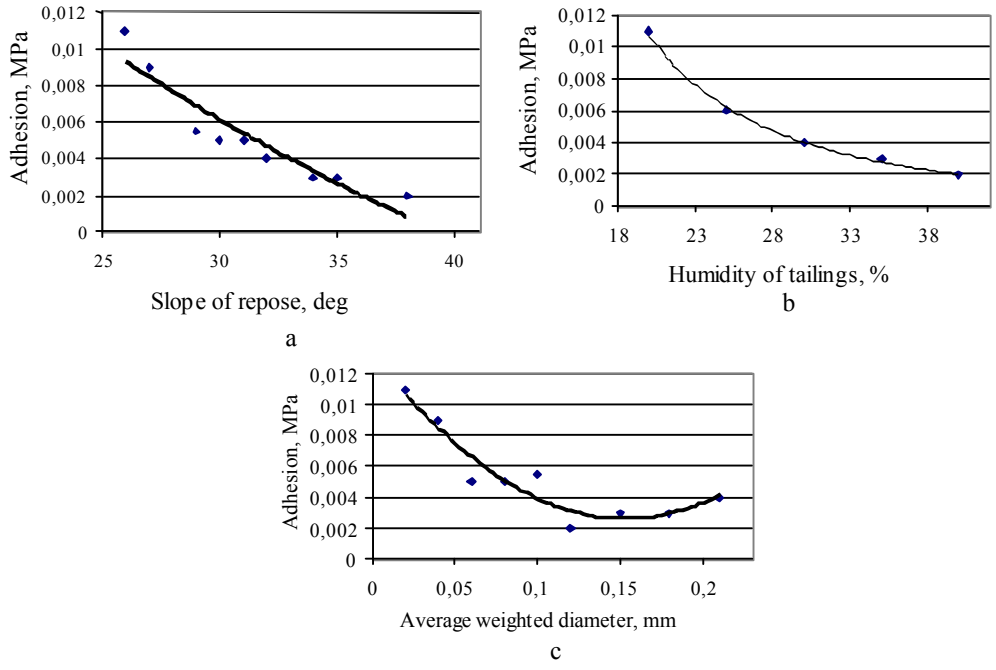

Fig. 3: Graphs of dependence of physical and mechanical properties of iron-bearing stale tailings:
a - adhesion on slope of repose; b - adhesion on humidity of stale tailings;
c - adhesion on average-weighted diameter of tailings

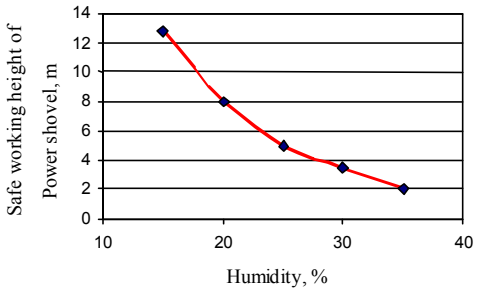

Fig. 4: Dependence of the safe working height of the power shovel on the humidity of tailings

Specific features of iron-bearing tailings dictate the need applying the formula of professor G.L. Fisenko to assess the safety factor of slopes at working benches of the back-acting power shovel which takes into consideration their hydrostatic weighing [4].

Based on computer-aided simulation and taking into consideration hydrostatic weighing the mathematical model was developed which takes into account the specifics of physical and mechanical properties of stale iron-bearing tailings, as well as the weight of the excavating and loading equipment located at the upper site. The initial stage of the task when developing the mathematical model is to determine the wedge width of potential failure.

As a result of the developed model the program was coded in QBasic which allows calculating the safety factor of slopes of the working bench (N) and the width of the wedge of potential failure. The program in QBasic is presented in Fig. 2.

To check the function of this program the results of previous studies [5] of physical and mechanical properties of stale iron-bearing tailings of the UGOK mill were taken into account (Fig. 3). Laboratory tests determining physical and mechanical properties of stale tailings dumped in iron-bearing tailing dumps were performed at the laboratory of Physical and Mechanical Properties and Rock Failure of the Mining University.

Initial conditions such as the depth of tailings watercut was accepted as zero; development was expected to be performed using the back-acting power shovel Hitachi ZX 850-3 with the dipper capacity 4.5 m^3.

The resulting data is input in the program in QBasic according to the flow graph algorithm.

The safe working height of the back-acting power shovel was determined based on the results of calculation the safety factor of slopes at working benches and solving of the equations. The dependence graph of the safe working height on the humidity of tailings was plotted (Fig. 4).

CONCLUSION

According to these calculations one can conclude that the application of the hydraulic power shovel Hitachi ZX 850-3 for the development of iron-bearing stale tailings at Lebedinsk mining and concentration complex mill is possible with the height of the gravel face 7 m and the humidity of tailings up to 22%.

Findings: According to the results of studies the developed computer model and the software in QBasic will allow to increase the intensity of mining operations, taking into consideration complex conditions of iron-bearing tailing dumps; to avoid unexpected landslides in the gravel face and it will reduce the out-of-service time of the excavating and loading equipment.

REFERENCES

1. Argimbaev, K.R., G.A. Kholodjakov and D.A. Ikonnikov, 2011. Extraction-and-loading equipment for the development of semi-dry tailing dumps. Development of mineral resources of the North: problems and solutions (issue 1), Vorkuta mining Institute, pp: 141-144.
2. Fomin, S.I., 2010. Ore reclaiming by the cyclical and continuous method at modern open-cast mines. Scientific Reports on Resource Issues, TU Bergakademie Freiberg (issue 1), pp: 100-104.
3. Fomin, S.I. and G.A. Kholodjakov, 2011. Opencast mining parameters evaluation at preliminary study of mining project. Scientific Reports on Resource Issues (issue 1), TU Bergakademie Freiberg, pp: 382-386.
4. Fomin, S.I. and G.A. Kholodjakov, 2012. Risk analysis method for opencast mining project. Mining and mineral processing (issue 55), University of mining and geology "St. Ivan Rilski" Sofia, pp: 23-28.
5. Kholodjakov, G.A., K.R. Argimbaev and D.A. Ikonnikov, 2011. Determining physical and mechanical properties of tailings of iron-bearing tailing dumps. Mining informational and analytical bulletin (Scientific and Technical Journal), 5: 93-98.