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Determination of the Angle of Natural Slope of Spherical Particles of Rock Lying On a Tightly Packed Rough Surface

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ABSTRACT: Since independence of the Republic of Uzbekistan, in accordance with the complex structural reforms, carrying out consistent steps to improve and develop the organizational structure of environmental quality and environmental management. In the context of economic reforms, the transition to market relations, population and urban growth, increasing transport volumes, intensification of agricultural and industrial production, solving environmental problems and related issues of rational use and reproduction of natural resources has become an important state task.

KEY WORDS: the contamination of soils, multiphase medium, a spherical particle with a rough surface and the centers of the balls, the inclination of the plane, the angle of separation of solid particles, dimensionless parameters.

I.INTRODUCTION

Near industrial areas there is contamination of soil, atmospheric and water basin zinc, lead, copper, cadmium, arsenic, Nickel, molybdenum and other toxicants, significantly exceeding the maximum permissible limits.

Million ton waste overburden deposits AMMK, NMMK and waste of enterprises of chemical production has created a new "artificial mountain", which is currently considered as techno genic deposits. The creation of production facilities for the integrated development of man-made deposits will solve a number of problems of mining cities and districts [1]:

-reduce pressure on local lab our markets;

-to increase the amount of funds coming to local budgets;

-reduce environmental pollution.

While the problems of use and processing of man-made deposits will get their solutions, it is necessary to find ways to reduce environmental pollution, as these deposits are a source of dust. During this process, the solid fractions of industrial waste (enrichment waste) after drying are easily destroyed by the wind, also easily transferred through the air, forming periodic dust storms, which leads to the dispersion of mechanical and chemical contaminants in the soil cover and surface waters. These phenomena are part of the motion of a multiphase medium. One of the types of motion of a multiphase medium is an erosion process, i.e. the demolition of solid particles by a gaseous or liquid phase. In nature, there are various types of erosion: dust and snow storms, water erosion. By origin, it is possible to distinguish the hydroerosis of metals caused by cavitation of the liquid (for example: in turbines), the bombardment of the surface by particles moving at supersonic speed; the removal of mass by a stream from the heated surface (from the practice of space exploration), the removal of soil due to ground and underground explosions and many others.

As can be seen from the above examples, the erosion process is mainly characterized as a negative factor and can be given single examples of the use of erosion processes in the national economy, such as grinding large and complex shapes of products in the fluidized bed of abrasive particles. In this regard, the study of the emergence and development of erosion processes is an important and urgent proble6moy.

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Knowledge of the laws of erosion processes allows to create scientifically-based methods of management of these processes and directs it to the benefit of society. One of the most common anti-erosion measures of mining is the construction of a dam and a pond-illuminator around the dumps. The structural parameters and dimensions of the dam and the illuminator pond depend on the parameters (trajectory, lifting height and flight length) of the eroded particles movement

To determine the trajectory of the solid rock fraction of different sizes [2] under the action of the wind flow, it is necessary to know the angle of its rise.

As the data [2] show, it is clear that

1. If the streamlined surface and the spherical particle are smooth, then under the action of the flow the solid particle roll on the surface. If the particle is irregularly shaped and flattened, the particle can glide on the surface.

2. The particle breaks away from the surface due to the rebound of the particles on the surface roughness, and the angle of rise of the particles depends on the forms of roughness. During the experiment, a vertical rise of particles was observed in the roughness of a rectangular shape.

3. The particle between the roughness's is detached at different angles depending on the size of the roughness and the rock particles under the action of turbulent flow.

In addition, field studies conducted by Bagnold indicate that the grains of sand jump almost vertically.

As can be seen from the above, the particle, depending on the size of the surface roughness, the particle is carried away at different angles. This process is directly related to the angle of the natural slope of the rock particles.

To describe this process, in the simplest case, the surface roughness is represented as a horizontal surface by fixed and tightly Packed spherical particles of size k. On this surface lie a spherical particle M of size d of mass m. During the support of spherical particles M on a rough surface can be two cases:

-Support of spherical particles M on three densely Packed balls -Support of spherical particles M on four densely packed ball's.

In both cases, the support particles occur under the action of gravity mg particles M. If you replace the support with the corresponding reaction forces, the process of separation of the particles occurs at some angle α corresponding when the reaction supports is zero.

II. SIGNIFICANCE OF THE SYSTEM

These problems are reduced to the problem of determining the reaction of the ball supports M, mass m lying on a tightly Packed layer of balls. The layer of the sphere is inclined to the horizon at an angle α (Fig.1, a). Let us consider the case of the support of one ball on three balls. We determine the reference reactions at the points of contact from the angle α, as well as the limit value of this angle, when the ball M mass m lies on a tightly Packed layer of balls (Fig.1,b).

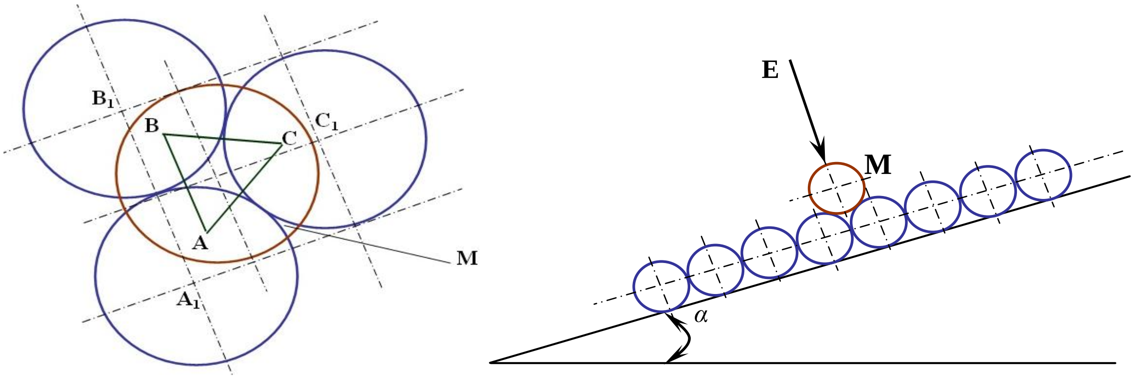

Fig.1

a) *b*)

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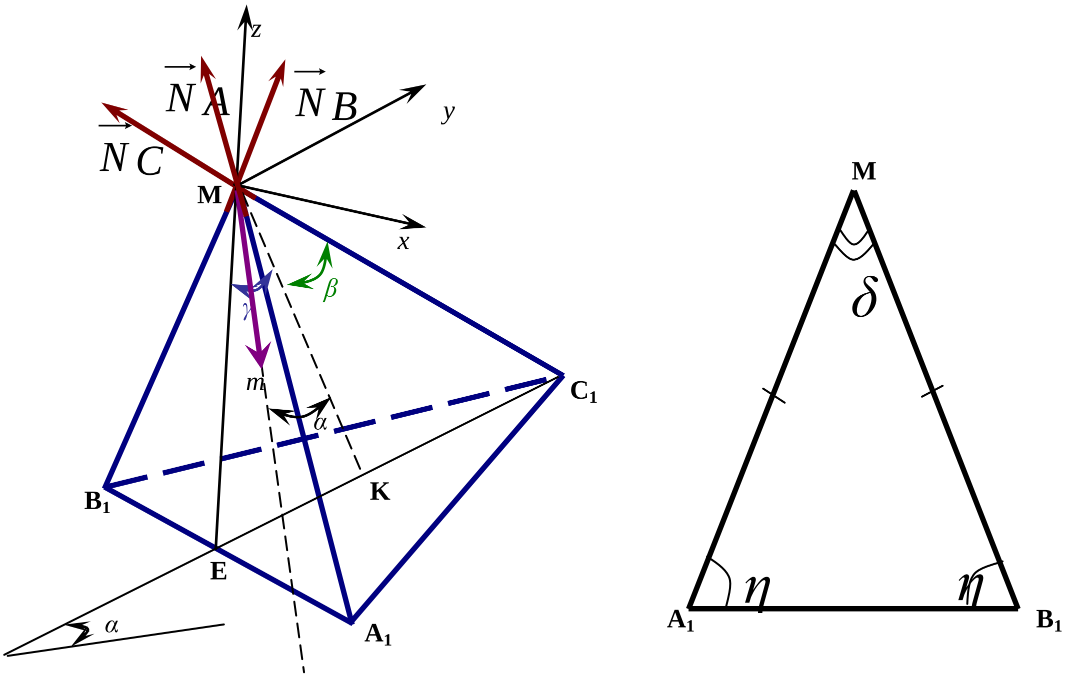
Plumage of the ball ***M*** at points ***A, B*** and ***C*** on three balls with centers A_1, B_1 and C_1. In this case $\Delta A_1B_1C_1$, it is located so that the diametrical axis passing simultaneously through both lower balls to the vertical plane containing the center of the ball ***M***, which is the plane of symmetry of the considered system of balls and at the same time – the plane of the largest slope (Fig.1,b.). The centers of the balls are ***M***, A_1, B_1 and C_1 are located at the tops of the triangular pyramid. The length of the side edges is d and the base is a regular triangle with side k (Fig. 2, a).

Reaction balls $\vec{N}_A$, $\vec{N}_B$ and $\vec{N}_C$ sent respectively to the ribs A_1M, B_1M and C_1M the pyramid i.e. the lines of action of the reactions converge in the same point of M. but the force of gravity $m\vec{g}$ ***M*** is applied in the same point, the ball acts spatially converging system of four forces, the equilibrium equation which in the coordinate system **Mxyz** (axis ***Mz*** is a continuation of apogamy ***EAT*** component with height ***MK*** pyramid angle γ and the axis of My lies in the plane of maximum slope) are of the form:

In an isosceles triangle ΔMA_1B_1, the base angles are η vertex angle δ (Fig. 2,b.).

$$\begin{aligned} \sum X_k &= -N_A\cos\eta + N_B\cos\eta = 0 \\ \sum Y_K &= mg\sin(\gamma-\alpha) - N_C\sin(\beta+\gamma) = 0 \\ \sum Z_k &= -N_A\sin\eta + N_B\sin\eta + N_C\cos(\beta+\gamma) - G\cos(\gamma-\alpha) \end{aligned} \quad (1)$$

Where $N_A = N_B = \dfrac{mg\sin(\alpha+\beta)}{2\sin\eta\sin(\beta+\gamma)}$; $N_C = \dfrac{mg\sin(\gamma-\alpha)}{\sin(\beta+\gamma)}$. Where $\sin\eta = \dfrac{\sqrt{d(2k+d)}}{k+d}$



A) *B)*

Fig.2

From the right triangle we have $\Delta A_1B_1C_1$ de

$$EC_1 = \sqrt{k^2 - \frac{k^2}{4}} = \frac{k\sqrt{3}}{2} \quad KC_1 = \frac{2}{3}C_1E = \frac{\sqrt{3}}{3}k \quad EM = \sqrt{\frac{(k+d)^2}{4} - \frac{k^2}{4}} = \frac{1}{2}\sqrt{2kd+d^2}$$

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then $\sin\beta = \frac{KC_1}{MC_1} = \frac{2\sqrt{3}k}{3(k+d)}$

From the isosceles triangle we find ΔA_1EM the angle γ in radians:

$$\gamma = \arcsin\left(\cdot\frac{EK}{EM}\right) = \arcsin\left(\frac{\frac{\sqrt{3}}{6}k}{\frac{1}{2}\sqrt{2kd+d^2}}\right) = \arcsin\left(\frac{k}{\sqrt{6\cdot k\cdot d+3\cdot d^2}}\right) \quad (2)$$

III. EXPERIMENTAL RESULTS

The limit value of the angle α is reached at a time when, with a gradual increase in the slope of the plane $A_1B_1C_1$ to the horizon, the pressure of the upper ball ***M*** on the support ball C_1 becomes zero and, consequently $\vec{N}_C = 0$, t. E. $\sin(\gamma - \alpha_{npe\partial}) = 0$ and $\alpha_{npe\partial} = \gamma$.

For rice.3 shows the change in the angle of separation of solid particles depending on the size of the constituent (k) and separating (d) particles in radians.

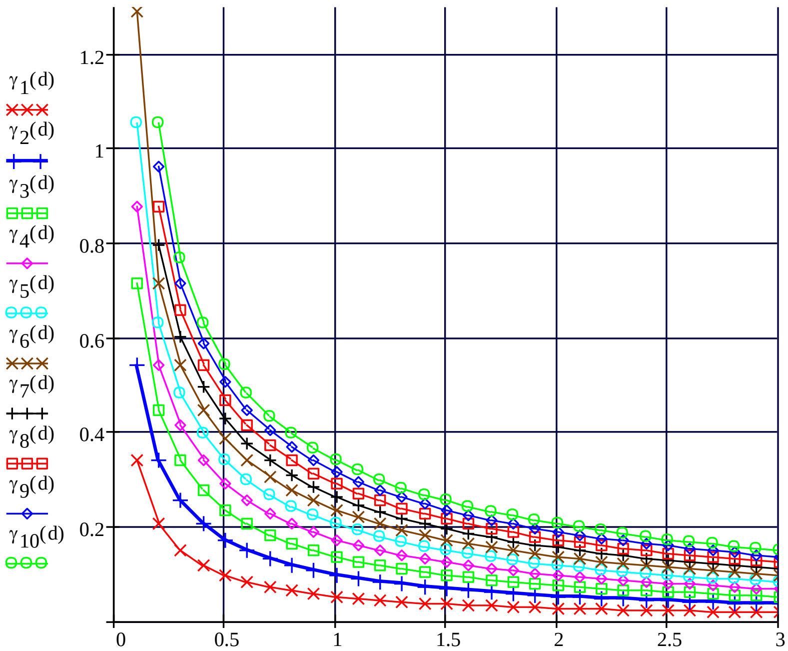

Fig.3

The line γ1(d) to γ10(d) corresponds to different sizes roughness, respectively: from k=0,1 to 1,0 mm.
Dividing the numerator and denominator (2) of the expression by d, we obtain the dependence of the angle of the largest slope on the dimensionless parameters ψ in degrees:

$$\alpha_{np.} = \gamma(\psi) = \frac{180}{\pi}\cdot\arcsin\frac{1}{\sqrt{3\cdot\psi\cdot(2+\psi)}} \quad (3)$$

Where $\psi = \frac{d}{k}$

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For fig.4 shows the change in the angle of the greatest slope (separation) from the dimensionless parameters that determine the size of the composing and tearing particles of the surface. Under natural conditions the non-dimensional parameter $\psi \approx 1$, so

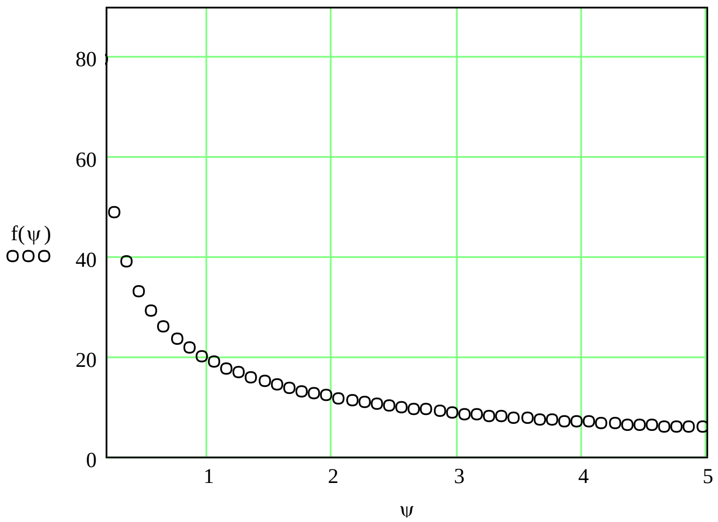

Fig.5

The obtained dependence (3) fully explains all the experimental data carried out by different authors under different conditions, if we assume that the angle of separation of particles under the action of the wind flow is equal to the angle of the largest slope of spherical particles of rock lying on a tightly Packed rough surface.
Since when the size of the roughness k→0, the parameter ψ→∞. This means that the rough surface becomes smooth and the corresponding angle of separation of the rock particles from the surface γ→0o. This is to say that the spherical particles of the rock from the smooth surfaces under the action of the flow moves without breaking away from the surface.
If the dimensions of the roughness k→∞, then ψ→0 and the corresponding angle of separation of spherical particles γ→90o. This is the rock particles of size d<<k that are in the shadow between the roughness sizes.
If the sizes of roughness's and particles of rock are equal among themselves (k=d), then ψ→1 and the angle of separation of particles from the surface becomes finite. This condition corresponds to the conditions of dusty drills in the steppes.
Ball M mass m lies on a tightly Packed layer of balls (Fig.6) determine the reference reactions at the points of contact from the angle α, as well as the limit value of this angle. Consider the support of three balls.

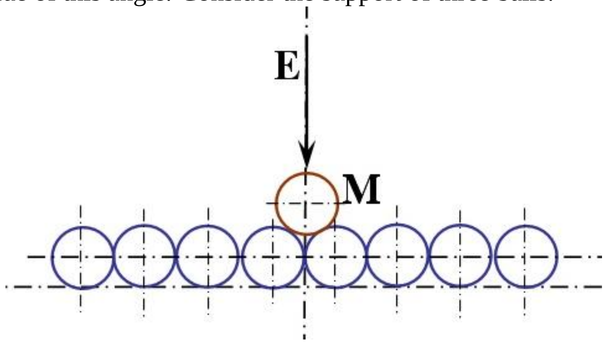

Fig.6

Solution: the Support of the ball ***M*** at points ***A₁, B*** and ***C*** on three balls with centers A_1, B_1 and C_1. In this $\Delta A_1B_1C_1$ case, it is located so that the diametrical axis passing simultaneously through both lower balls to the vertical plane containing the center of the ball ***M***, which is the plane of symmetry of the considered system of balls and at the same time - the plane of the largest slope (Fig.2). assoy m lies on a tightly Packed layer of balls (Fig.7) determine the

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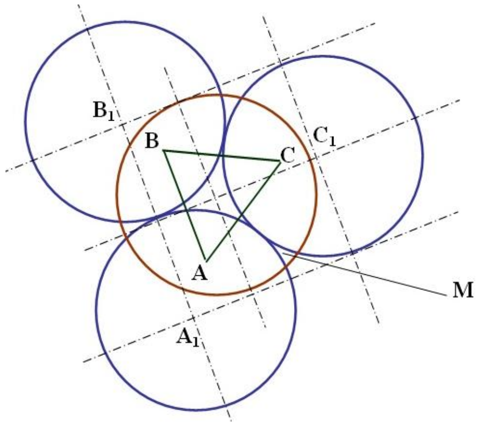

Fig.7

IV. CONCLUSION

The centers of the balls are M, A_1, B_1 and C_1 are located at the tops of the triangular pyramid. The length of the side edges of which is d and the base of the right triangle with side k (Fig. 8).

Reaction balls $\vec{N}_A$, $\vec{N}_B$ and $\vec{N}_C$ sent respectively to the ribs A_1M , B_1M and C_1M the pyramid i.e. the lines of action of the reactions converge in the same $m\vec{g}$ point of ***M***. but the force of gravity ***M*** is applied in the same point, the ball acts spatially converging system of four forces, the equilibrium equation which in the coordinate system ***Mxyz*** (axis ***Mz*** is a continuation of apogamy ***EAT*** component with height ***MK*** pyramid angle ***γ*** and the axis of ***My*** lies in the plane of maximum slope) are of the form:

In an isosceles triangle ΔMA_1B_1 base angles are equal to ψ vertex angle ***φ***.

$$\sum X_k = -N_A \cos\psi + N_B \cos\psi = 0$$

$$\sum Y_K = mg\sin(\gamma-\alpha) - N_C \sin(\beta+\gamma) = 0$$

$$\sum Z_k = -N_A \sin\psi + N_B \sin\psi + N_C \cos(\beta+\gamma) - G\cos(\gamma-\alpha)$$

Where $N_A = N_B = \dfrac{mg\sin(\alpha+\beta)}{2\sin\psi\sin(\beta+\gamma)}$ где $\sin\psi = \dfrac{\sqrt{d(2k+d)}}{k+d}$ $N_C = \dfrac{mg\sin(\gamma-\alpha)}{\sin(\beta+\gamma)}$

From the right triangle $\Delta A_1B_1C_1$ we have

$$EC_1 = \sqrt{k^2 - \frac{k^2}{4}} = \frac{k\sqrt{3}}{2} \implies KC_1 = \frac{2}{3}C_1E = \frac{\sqrt{3}}{3}k$$

$$EM = \sqrt{\frac{(k+d)^2}{4} - \frac{k^2}{4}} = \frac{1}{2}\sqrt{2kd+d^2}$$

Then $\sin\beta = \dfrac{KC_1}{MC_1} = \dfrac{2\sqrt{3}k}{3(k+d)}$

From the isosceles triangle ΔA_1EM we find the angle γ:

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 5 , May 2019

$$\gamma = \arcsin\left(\frac{EK}{EM}\right) = \arcsin\left(\frac{\frac{\sqrt{3}}{6}k}{\frac{1}{2}\sqrt{2kd+d^2}}\right) = \frac{k\sqrt{6kd+3d^2}}{6kd+3d^2}$$

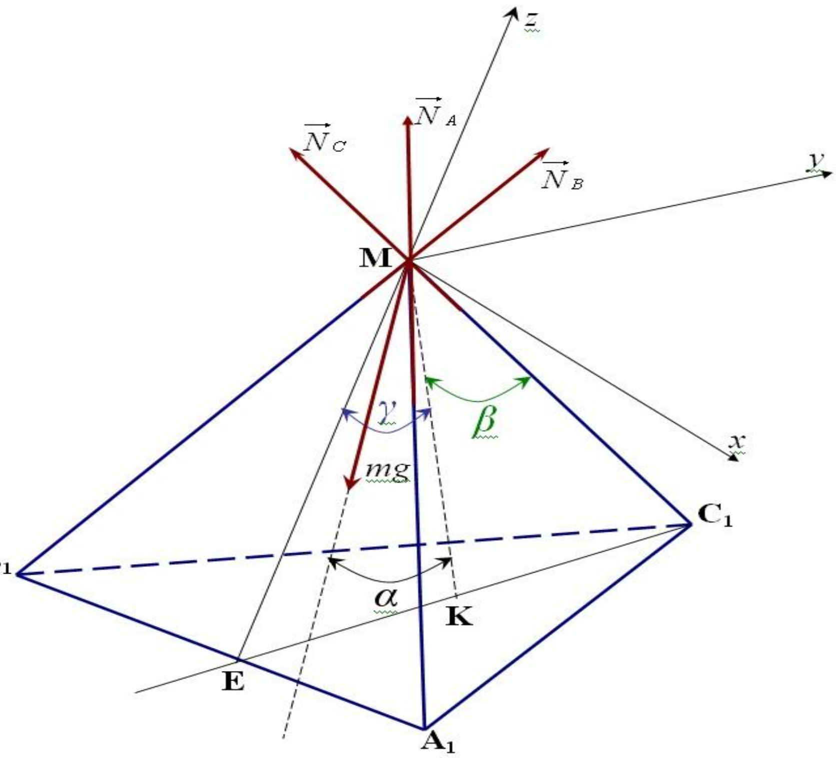

Fig.8

The limit value of the angle α reaches at the moment when, with a gradual increase in the slope of the plane $A_1B_1C_1$ to the horizon, the pressure of the upper ball M on the support ball C_1 becomes zero and, therefore, the isosceles triangle, we find the angle γ: $\vec{N}_C = 0$

$\sin(\gamma - \alpha_{пред}) = 0$ и $\alpha_{пред} = \gamma$

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