

ON THE KINEMATICS OF DESTRUCTION OF ROCK MASSES AS A RESULT OF LANDSLIDES AND MINING OPERATIONS

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ABSTRACT

Usually a little attention is paid to kinematics of particles of destruction on processes and mainly dynamic and physical topics are referred. The paper reveals that this matter referred to landslides is rather important for complete assessment of phenomena. Some final conclusions and recommendations are presented.

It is well known that cylindrical surfaces belonging to circular cylinder are the only curvilinear surfaces on which rock mass slidings as plane systems are possible. Great number examples of such slidings are observed. On fig 1 is presented

such a case, taken from the reality. For many important building sites had been possible to think about such movements or heavy results from such movements to be carried.

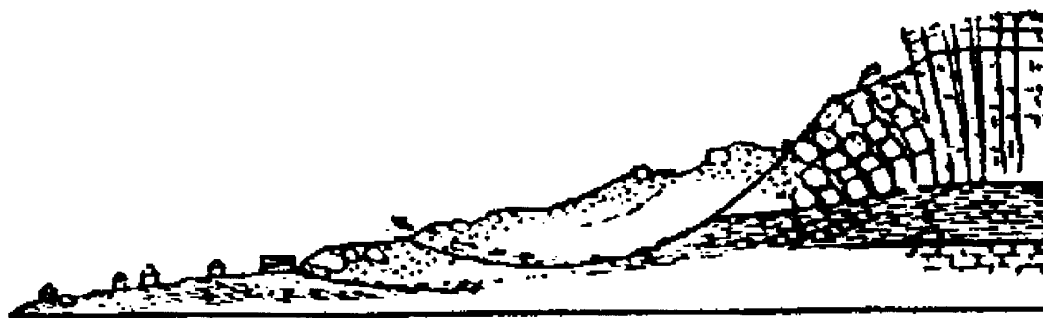


Figure 1

And naturally arises the question how could landsliding movement be presented, how stress and strain status of rock mass to be described in general, and what is the way such movements to be foreseen.

Here we will note that we are not interested of sliding movement itself. It is too complex to be described mathematically correct. In some cases it develops in an avalanche way and it is really not possible to be described mathematically correct. We only strive to discover forces interaction at the moment just before sliding movements start.

In another words we try to discover the forces active or retaining just before sliding movements start. Also phisicomathematical parameters generally factor of friction and factor of cohesion must be known.

To decide this difficult mathematical problem, we must have in our disposal some rock mass parameters such as its structure, data about its loosening, water circulation, applied (outer) forces from useful loads, vehicles eventual blasting

works, seismic waves, piles driving in and other dynamic influences.

But our attention will be concentrated generally towards one side of the phenomenon, very rarely discussed with necessary completeness and correctness. Very often the fact, that sliding movement together with all other sides, very strictly defined kinematic properties. Here we have in mind the kinematical geometry, leading to definite position function and to infinitesimal properties, which follows from the fact that for state of equilibrium only ordinary equation for free rigid body are not enough, but equation, coming from the principal of virtual replacements must be taken into account (Г.К Клейн, Стр.Механика Сыпучих тел М.1977, стр.91).

Thee principal of virtual replacements requires introduction in the most cases of a decart coordinate system and demands rather heavy way of virtual replacements description by using partial derivatives of functions in decart coordinates. Besides, there has not thought for observation the rock mass problem as an elastic, or elastoplastic, homogeneous or heterogeneous body. Correct, well pointed and practically verified

investigations in this directions are made very long ago (B.B.Соколовски, Н.Н.Маслов, Г.Л.Фисенко, Robert Schuster, Raymond Krizek, С.С.Голушкевич), but all of them require very laborious operations.

It is practically necessary methods to be used, which permit some procedures to be repeated hundredth or thousands times. And such populations of results to be selected from which convergence to only one defined numerical result is evident. These are the only cases when the result obtained leads to correctly foreseen events. A team of scientists from University of Minig & Geology from which this article comes, is pointed to such results and usage of such relevant methods.

Method, proposed in this article is connected with special kind of modeling by systems of n - angles polygons (n is equal or bigger than 2). When system moves, multiangle polygons are moving too. But for equilibrium problems is necessary to use only virtual displacements. Virtual displacements are isochronous (not time dependant). All applied on the system forces rest unchangeable during movement. Systems consists of blocks and very often relative block displacements are discussed. Moving multiangle polygons bordered intermediary surfaces with small areas between neighbouring blocks.

Because of the small area of intermediary surfaces and small angles (only parts of the degree) and angles, very near to 180° correct description of intermediary surfaces is very difficult. Their drawing is practically impossible. Because there is not such precise devices for drawing only parts of the degree angles. In spite of that, correct decision is possible and necessary. In many cases big number of polygons must be composed. This is the reason a particular principally new in method to be created, described below.

What is the essence of the method. Instead of the small difficult to be presented polygons, big polygons are composed and then reduced keeping the principal of mechanics for all active and retaining forces for defined points of polygons. As all displacements are brought to virtual displacements, all active and retaining forces will rest unchangeable at any movement, i. e. they will receive only translations and will neither change their values nor their directions. And of course neither convergences nor work of the forces will have physical sense. Especially displacements of polygons and connected to them rock blocks are unbelievable or even impossible on the first look. But these unbelievable pictures will disappear when defined, specially chosen parameters- by nature- generalized forces begin to tend to zero and this small values of the angles and itther dimensions will be reached which we have in reality. The benefit of this scheme of work is, that all polygons and the expressions for forces work can be described mathematically and calculations to be done with arbitrary correctness. Than all final results can be followed and took as correct at this boundary translation.

It will be demonstrated on simple examples how this method is applied. As a most simple block scheme will be taken this one on fig 2.

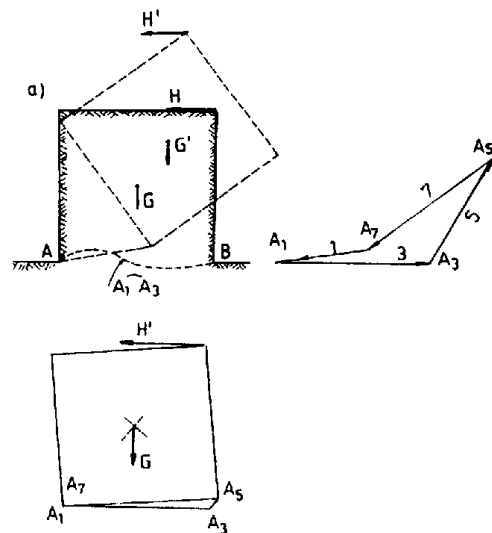


Figure 2

It consists of one single block, which is prismatic and on scheme a) its base can be seen. Many forces are applied on the block. If connections between particles of curve A and B vanish, under the action of forces presented- active and retaining, block will converge and on scheme b) is presented the new position. It is not physically possible. And calculated results of forces work are useless for any purpose. They are obtained just to compose correctly expressions for works and trough them, reducing the parameter nearly with zero, we obtain an expression very near to the sum of virtual works. But from it is very easy to obtain equilibrium expression, which is the final aim. And this equation can be used to go to investigation of stressed and strained block status. On the next schemes on fig. 3 are schematically presented many well known from the practice cases. It can be seen a slope after removal of part of the rock mass, restricted by the straight line AE.

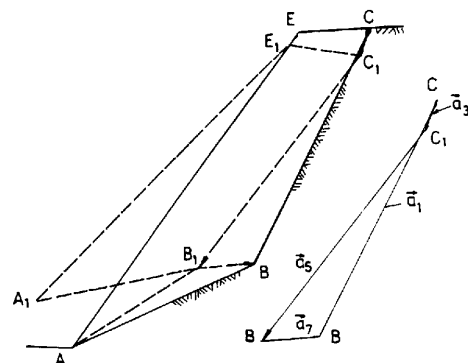


Figure 3

Under the action of active and retaining forces, the block realizes imaginative displacements and from position ABCE, comes to position A1, B1, C1, E1. With the aid of quadrangle BCC1B working forces are calculated and after the translation equilibrium equations are obtained, accepted as real ones. On fig. 4 is presented a rock mass, supposing that it is bordered by circular- cylindrical surface, divided to several elements. Trough the same procedure, for a defined element a procedure

of imaginative movement of all rock mass is made and after calculations this leads to real force interaction between elements. Procedure proposed has the advantage, that it responds the question, concerning the interaction on vertical walls of the elements. This important disadvantage of previous methods is pointed out by some authors (mentioned above Клейн, Цытович).

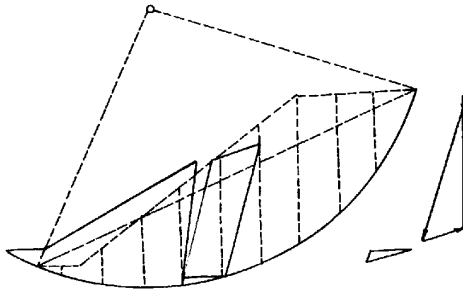


Figure 4

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