THE STABILITY OF THE HEAP BRANCH II COROIEȘTI - E.P.C.V.J. VULCAN

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Abstract

Research on the stability of the heap have begun by setting the factors that contributes to instability, after which the steady state analysis of talus using several methods of calculation, and in the end, were designed some steps to stabilise tripping or slipping.

The stability analysis was performed using the dedicated geotechnical software Slide.

After the stability analyses it can be concluded that the heap Coroieşti Branch II is stable when the sterile material is deposited under normal conditions of humidity and may become unstable in terms of increasing the humidity up to saturation, what it is, however, unlikely, considering the large capacity of dispose of water by the stockpiled rocks.

Keywords: heap, stability, resizing

1. General considerations

Landslides are geo-dynamic occurrences altering the relief, with a generally slow and periodically character, which restores the natural balance of mountainsides and slopes. When they occur unexpectedly, depending on their location, landslides may result in loss of life and substantial material damage.

The slopes sliding occurrences take place, usually, when the local balance or assembly of forces that stress them is destroyed and the internal solidity forces that oppose sliding is destroyed, under the effect of internal and external factors, natural or artificial.

2. Stability analysis

In terms of morphology area deployment of branch RII Coroieşti, the surface stockpiled is an irregular surface, represented by the hillsides in the area. Their inclination favors the occurrence of slides on the surfaces of contact heap – base terrain when accordance between the inclination of mountainsides and expansion of heap exists and ensures stability when declivity is reversed – just like the west slope of the pillars P2 and P3.

For the first case, with increasing declivity of the base terrain the tangential component of the sliding forces is amplifyed and the stability reserve is reduced. In such cases the literature recommends the build up in stairs or scabbing when the declivityes of the base terrain is above 10°.

In case of branch RII, the occurrences that could change the ratio between the forces of resistance and the active sliding forces of the slopes by impairment appear on the North side because of the presence of Priboi gill.

It's considered that today, because of the absence of expanding developments of the heap in this area, the erosion activity of the gill is very depressed. The other erosion processes as gap formation due to drip waters, although they are present, they can't change into proper slides themselves.

In case of the heap bellow branch RII we can see overloads of the slopes by rocks deposit and increase of geometrical elements. The bigger the values, the frequent the processes of deformation and instability can be.

In case of heap bellow branch RII, the slopes angles generally correspond to the natural slopes angles of rocks and they depend on the granulometric property and the index of compaction of material.

According to the surface mapping for the transversal and longitudinal sections, the slopes angles are between 28-33° and can reach 40-44° and the heights of the slopes change because of the morphology of the terrain and the configuration of the heap, values being registered of 21-30 m, reaching 50-69 m.

Because the values of those parameters are quite large new process of instability can appear that would affect the surrounding areas therefore certain geotechnical measures would assert.

To analyze the stability of slopes, Slide has been used, a software specialized in geotechnical analyze. Slide analyses the stability of natural and artificial slopes by any geometry, both in statically conditions, seismically and by analyzing the presence of water in the pores of the dumped material or on the slope of the heap.

The first stage in the usage of Slide is entering the geometrical and geotechnical elements that characterize the slope, then the definition of the slide surfaces.

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The software automatically calculates the stability factors, using for this the Fellenius, Janbu and Bishop methods. Finally, the critical sliding surface is determined, which coincides to the minimum value of the stability index.

The software analyses the stability of slopes and natural mountainsides with complex geometry, homogeneous and heterogeneous, considering the hydrostatical level both in normally static conditions and in the influence of seismically shocks.

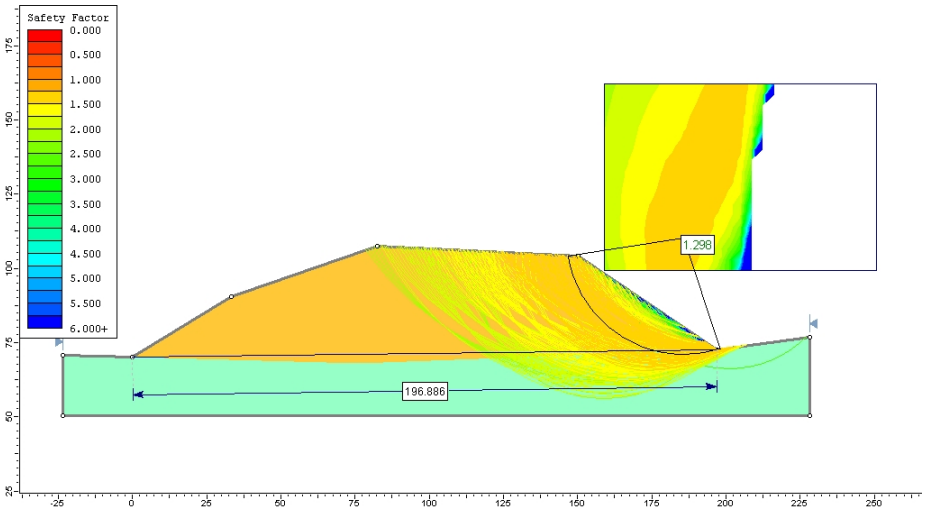

Fig. 1 *Transversal section T3-T3 –eastern slope, natural humidity*

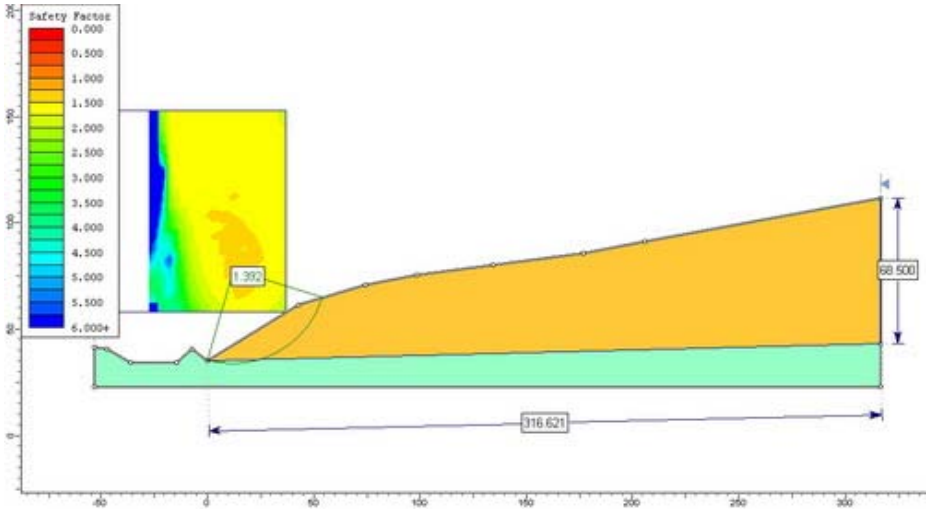

Fig. 2 *Longitudinal section L1-L1 –northern slope, natural humidity*

Table 1. *Stability analysis for cilindrico-circular sliding surfaces*

Section	Maximum heigth	Angle of slope	Methods used		
	H (m)	α (degrees)	Bishop	Fellenius	Janbu
T1-T1 western slope	43,157	35	2,063	1,850	**1,822**
T1-T1 eastern slope	42,845	33	1,922	1,831	**1,797**
T2-T2 western slope	41,707	28	1,464	1,346	**1,326**
T2-T2 eastern slope	41,756	41	2,180	2,000	**1,968**
T3-T3 western slope	40,501	33	1,650	1,525	**1,506**
T3-T3 eastern slope	39,016	44	1,398	2,322	**1,298**
T4-T4 western slope	21,927	32	2,807	2,620	**2,548**
T4-T4 eastern slope	21,927	42	1,783	1,622	**1,599**
L1-L1 northern slope	68,500	30	1,538	1,410	**1,392**

Using the Fellenius method, the software automatically calculates the effective weight of sections, considering the real hydrostatical level.

Janbu's method used by the software is a simplified version, extrapolated for the situations in which the slope has more layers with different physical-mechanical properties and it's based on the calculation of the effort to lump meaning the hypothesis of multiple section calculation.

First, the software determines the value of the stability index using Fellenius's method and then it uses the calculated value as a starting point for the iterative cycle. Considering that we can analyze using different software the slopes made of multiple layers with different geotechnical parameters, those software determine the weighted average of the coefficient C_f.

From the table we can observe that the smallest values are given by Janbu's method. We haven't considered the values of the physical parameters, the cohesion and the internal angle of friction to the moisture saturation, because, generally, Jiu Vallye's heaps (because of the material's granulometry and the permeability slightly raised) assure a good drainage of the waters from rain.

For all of the sections analyzed, conditioned by the physical-mechanical characteristics of the material used in natural humidity, higher than one values for the stability index have been calculated, over 1.3, recommended by the Technical prescriptions concerning the design, execution and conservation of heaps.

At the limit of stability is the eastern slope from the section T_3-T_3 ($Fs < 1,3$), the others being slopes that become instable only in the presence of a material with the humidity on its saturation, as a result of higher geometrically elements (height and tilt) that are less favorable.

Based on those presented, we can conclude that branch RII of Coroieşti heap is stable when the dumped material is stored on normal humidity conditions and risks to become unstable when the humidity raises to the saturation limit, which is, still unlikely, considering the large capacity of water disposal that dumped rock have. One of the reasons of sliding could be the failure to regard the geometrical elements of build up in stairs, especially the tilt of slopes, as a lack of slope maintenance and the development of intermediate berms.

3. Resizing the geometrical elements of slopes

Based on the results of stability analysis made for several slopes with different combinations of height and slope angle, for the result of sizing calculation and the technological characteristics of dumping it's recommended to ensure a geometry of the heap so that the height of the slopes are top 25 m and the angle of the slopes is maximum 35°.

Considering the existent slides on the eastern slope from this area, stable by this time and the current configuration of the terrain, is proposed the re-geometrization by developing intermediate berms at height +665 and +680 that would build the slope in stairs with a maximum height of 15 m that would meet the stability requirement of slopes even if the humidity of rocks is at the saturation limit.

By this re-geometrization of the eastern slope, at the northern limit of the heap, is assured, on one hand, the increase of dumping capacity on the heap and on the other hand, mining redevelopment and biologically recultivation.

4. Measures to assure the stability of the heap and protection of the environment

Considering the characteristics of the base terrain, the shape of the heap and the factors that influence the stability, the analysis made for the slopes of branch RII of Coroieşti heap, was made thinking that most likely the slide occurs on cylindrical-circular surface, the sliding process risking to affect some areas of the eastern slopes, respectively the western side of the heap.

Instability problems can occur under the build-up of rock humidity, on the saturation limit, by worsening the resistance characteristics of the dumped material. Sliding occurrences can appear near pylons P1, P3 and P4, if the humidity of the dumped sterile reaches the saturation limit, which is unlikely, considering the configuration of the heap and the bordering areas that favor the flow of water, the possibility of infiltration and drain of water because of high permeability of the dumped rocks.

To ensure a greater stability of the dumped volume of sterile in the last three years, a re-geometrization is recommended so that the angle of the slope is decreased to 30°, renouncing the actual 44.5°. Therefore is recommended a process of rearranging from top to bottom using a bulldozer.

Rearranging from top to bottom consists in displacing the rocks from the top and requires bigger surfaces of terrain to store the entire volume of rocks initially stored and can be done any time the required surfaces are available. To do so, excavator type draglima, type shovel with large working parameters can be used, but the most used is the bulldozer. According to the angle that is used to rearrange the slope we can calculate the volume of material that needs displacement and the time required to achieve.

To protect the environmental factors from the areas affected by the presence of heaps a series of measures need to take place, among the mentions:

a. Measures to prevent the pollution of ground waters and surface waters by harmful substances that could drain in Priboi gill. Because the extracted material doesn't contain harmful substances, there's no water pollution with this kind of substances.

b. Measures to avoid carrying the dumped material by running water. This means bed planning work of Priboi gill and the avoidance of carrying of dumped material by the drip waters from the slopes by directing them to the sides, foresting and grassing marginal slopes.

c. Measures to avoid carrying the dust particles by predominant winds. This is not applicable here, although the heap is done by aggradation, because the granulation of the dumped material is large. Sources of dust are created by disintegration and alteration of rocks from the slopes and this is the reason why grassing the slopes is recommended in the areas where dumping is no longer achieved.

5. Conclusions

The heap U.P. Coroieşti branch RII, was classed 4.2 by the nature of objectives from the area of influence and degree of stability, according to "Technical prescriptions regarding the design, the execution and the conservation of heaps", 5-th appendix from "Specific rules of work protection for the coal mines, shales and bituminous sands", 1997-th edition, being considered a relatively stable heap that could move dangerously if certain factors are met (relief condition, meteorological condition, accumulation of water in upstream, water infiltration at the base and so on) without constructions and sporadic access of persons in the area.

Is made in a single step with heights between 10÷12 m and 47÷50 m, according to the terrain configuration and the deposit geometry.

The heap bellow branch RII has a regular geometry except the northern part from pillars P4 and P5 where slides occurred in 1999 and pillars P2 and P3 in 2006. The upper platform elevations varies between +714.04 m in the southern extremity, +681.85 m in the northern extremity, and it's width between 60÷115 m.

Based on those presented, we can conclude that branch RII of heap Coroieşti is stable when the dumped sterile material is in normal natural humidity conditions and risks to become unstable when the humidity increases to the saturation limit, which is, unlikely, considering the large capacity of water disposal by the dumped rocks. One of the risking sliding reasons may be the failure to regard the geometrical elements of build up in stairs, especially the tilt of slopes, as a lack of slope maintenance and the development of intermediate berms.

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