ANALYSIS OF THE SAFETY FACTORS OF THE FLOORS OF THE INTERNAL LANDFILL FIELD B/C IN THE FUNCTION OF OPENING FIELD E IN MB KOLUBARA

Expert Paper
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Abstract: *During 2006, the internal landfill FIELD B/C - MB KOLUBARA was destroyed, so the process of coal mining in that part of MB KOLUBARA was prevented. Unsuccessful rehabilitation of that area was a big problem during coal mining from that mine, which caused the displacement of the tailing systems from that zone and their transfer to the area of the internal landfill FIELD D. However, even after 17 years, the landfill has not been rehabilitated and fully put into operation, so the problem with overburden disposal is still current. The internal landfill FIELD B/C represents the space intended for the disposal of overburden from FIELD E, so that the coal from FIELD E could be excavated without any difficulty. Without permanent and successful rehabilitation of the internal landfill FIELD B/C, there will be no opening of FIELD E, which will certainly have a negative impact on the Serbian energy security.*

Key words: SLOPES, INTERNAL LANDFILL, SAFETY FACTOR, REMEDIATION

INTRODUCTION

Field C covers the eastern part of the Kolubara coal basin, with an area of about 2.6 km^2. The structural characteristics of coal do not differ generally so that FIELD C represents a natural extension of FIELD B and further west towards FIELD E. Considerable exploration work carried out in this area has contributed to the definition of genetic, geomorphological and qualitative characteristics of the coal layer and associated mineral raw material (diatomaceous earth, quartz sand, etc.).

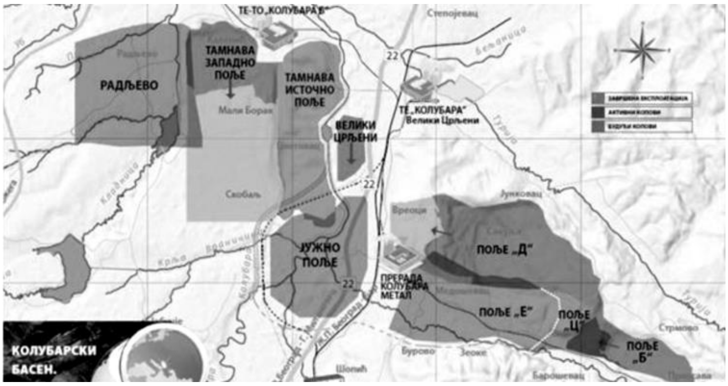

Figure 1, Review map of the Kolubara coal basin with exploration and exploitation fields [1]

At the end of 2005, a major motion of the disposed masses was registered at the internal landfill FIELD B (space intended for the external landfill FIELD C and later FIELD E), which in early 2006 caused the landfill to collapse and lead to the closure of the space between the landfill and the working coal floors. Therefore, the floors were backfilled with that slippery material, which stopped the technological process of coal production (Figure 2). The deposited material mainly consisted of gray-blue clays with variable content of sandy components, fragments of coal and diatomites, gray-yellow clay with quartz pebbles, clay sands, carbon clay, pieces of diatomite and coal.

Figure 2, Internal landfill FIELDS B (slip masses), 2006. [1]

Remediation of the landfill began at the end of 2006 with the construction of a network of wells and the installation of plastic pipes in them for the purpose of draining water from landfills. Along with this started the formation of ballast (12 m in height) on the surface of the landfill, which, due to its load, would contribute to elimination of water from the landfill through these wells. However, due to the demolition of this ballast, and then the newly formed floor of the landfill, works on the remediation of the landfill have been permanently stopped and the existing situation has remained unchanged to this day. This problem of unsanitary landfill has been neglected for years, despite the fact that such a situation has disturbed the scheduled development of active mines, which subsequently negatively affected particularly the opening of new mines within the MB

KOLUBARA. There is no doubt that if the internal landfill FIELDS B/C is not repaired, there would be no possibility for opening FIELD E, which would prevent the coal from that mine to be used, thus directly affecting the energy security of Serbia. This paper presents an analysis of the stability of the slopes of the internal landfill FIELDS B / C as well as the newly formed embankment (support) at the head of the landfill, which will be in the function of supporting the landfill.

CHRONOLOGY OF EVENTS AT THE B/C FIELD INTERNAL LANDFILL

As previously noted, during 2006, a large amount of disposed material (about 80 million m^3) had slided at the field B/C internal landfill. This material also backfilled the coal floors so that the entire process of mining in this area was stopped. Figure 3 shows the state of the floors at that time.

Figure 3, The appearance of the internal landfill afther backfilling of coal floors, 2006. [1]

In order for coal mining to continue, it was necessary to define how to rehabilitate the entire area that was jeopardized by slippery material. In 2007, the rehabilitation started, but the proposed method of remediation did not give effect, more precisely, the wrong approach to solving the problem caused new slides of the material so that all activities on the rehabilitation had to be stopped (Figure 4).

Figure 4, Repeated sliding of disposed material and breakage of coal floors, 2007. [1]

After these events, there were no more works carried out in this area in order to rehabilitate it, except the filling of this zone with new amounts of overburden. Due to the phenomena of new displacements of disposed masses, all tailing systems from FIELD B/C have been moved to the area of the internal landfill FIELD D, so that this state has been maintained to this day. Due to the need to open a new mine FIELD E and to dispose of a large amount of overburden from that excavation field, the internal landfill FIELD B/C must finally be remediated.

ONE OF THE WAYS OF REMEDIATION OF INTERNAL LANDFILL B/C FIELD

As early as the end of 2006. Prof. Milan Cvetković and his associates suggested a solution for the rehabilitation of the internal landfill of field B and the continuation of coal mining from that mine. Making a drainage channel in the foot of the lowest floor of the landfill, forming a stone support above it and making transverse drainage channels under that support in order to drain it, most precisely defines this solution.

In addition to stone, for the manufacture of supports could be used material that is disposed of, only with prior preparation of the field (constructing a system of drainage channels and installation of geotextiles to increase the bearing capacity of the groundwork).

Before starting with the formation of supports, it is necessary to bring the floors of the landfill to a stable state in order to avoid their collapse. This paper presents an analysis of the slope stability of the internal landfill FIELD B /C, both without support and with it. The current state of the landfill with the position of profiles C - C and D – D for which the analysis was done, is given in Figure 5.

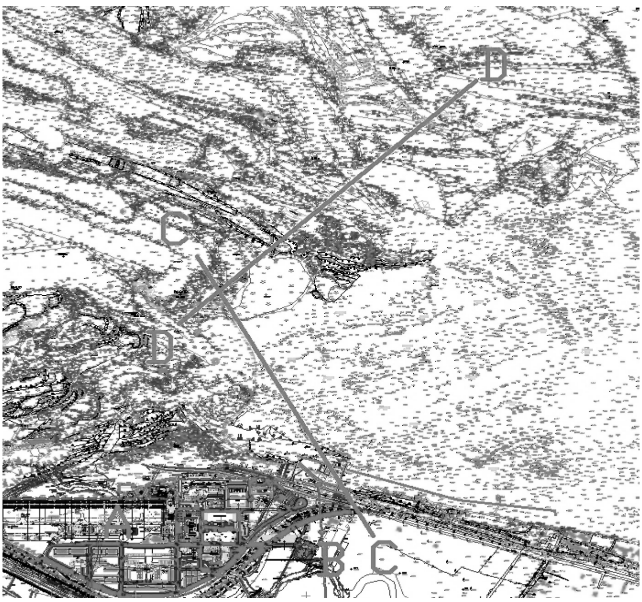

Figure 5, Internal landfill FIELDS B/C with profiles C – C and D – D [1,3]
Figures 6 and 7 show cross-sections of these profiles

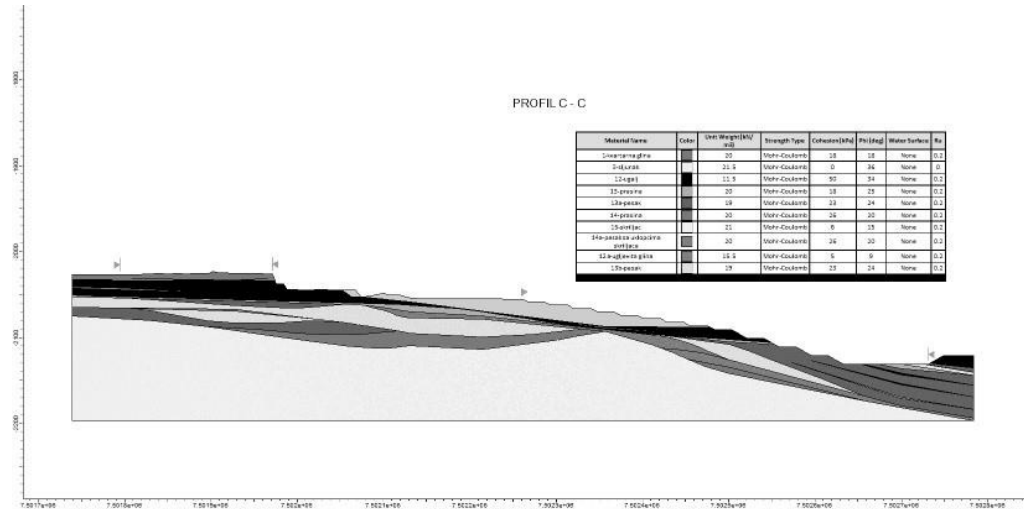

Figure 6, Cross-section of Profile C – C

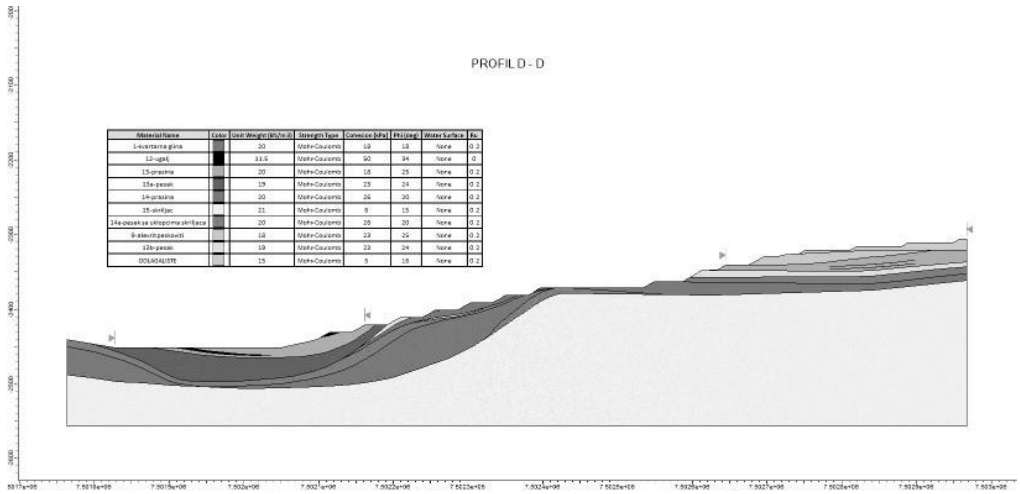

Figure 7, Cross-section of profile D – D

The calculation of the floor safety factor (Fs) was done using the SLIDE 6.0 software package, Rocscience Inc, with Mohr-Coulomb's failure criterion. The results of the calculation are presented graphically and tabularly. Partial slopes, slope system and general slopes were analyzed. The safety factor (Fs) values for profile C-C slopes are shown in Table 1.

PROFILE C - C

The height of the partial floors at the landfill H = 4 m; slope of partial floors at the landfill $\alpha = 30^{o}$;

The height the first floor above the coal H = 5 m; slope of the first floor $\alpha = 30^{o}$

The height the floor on the coal H = 10 m; slope of the floor on coal α = 30^{o}

The height of the other floors H = 10 m; slope of other floors α = 30^{o}

Width of the berm b = 20 m;

Height of general slope H = 76 m; general slope inclination α = 12^{o}; (Figure 8).

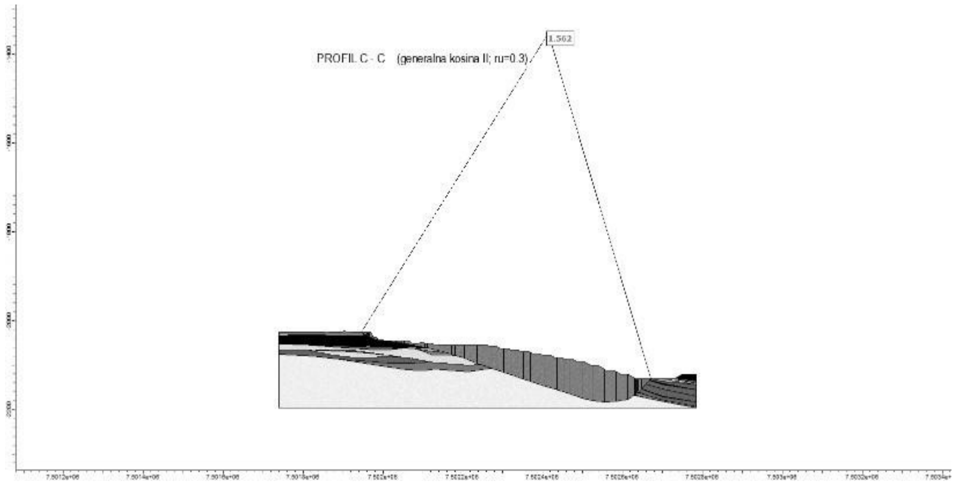

Figure 8, Security factor (Fs = 1.56) of the general slope of Profile C – C

Table 1, Safety factor values for Profile C–C

Namber of floors	Fs
I	2.47
II – VIII	1.49
IX	8.03
X	4.22
XI	2.56
XII	1.92
XIII	2.00
slope system I	1.56
slope system II	1.52
general slope	1.56

PROFILE D – D

The height of the partial floors at the landfill H = 5 m; slope of partial floors at the landfill α = 30^{o}

Height of the general slope H = 146 m; general slope inclination α = 9^{o}; (Figure 9).

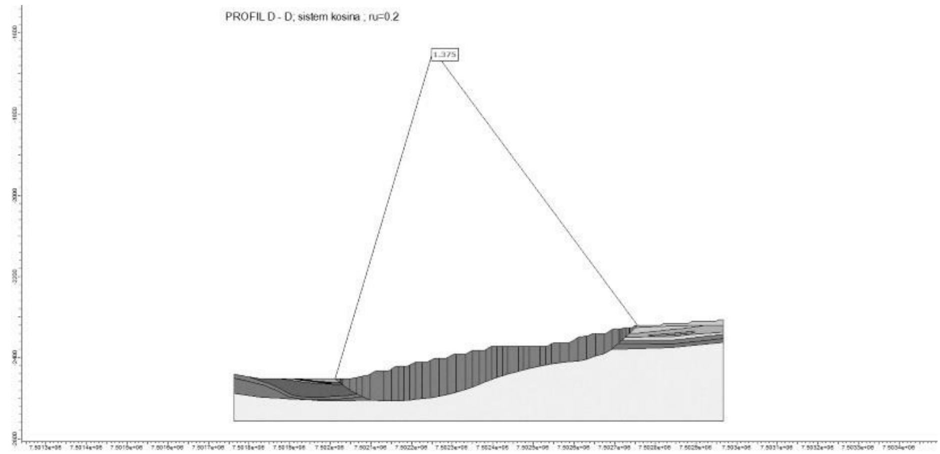

Figure 9, Safety factor (Fs = 1.38) of the slope system of the Profile D – D

Table 2, Security factor values for Profile C–C

Namber of floors	Fs
I	2.34
II	1.21
III	3.47
IV	1.69
V	3.03
VI	1.32
VII	2.12
VIII	1.79
IX	1.81
X	1.79
XI	1.80
XII	1.84
XIII	1.99
XIV	1.82
slope system I	1.41
slope system II	1.45
general slope	1.38

A protective embankment (support) from the deposited material can be formed so that its partial slopes have a height of H = 8 m and a slope of $\alpha = 28^o$.

It is necessary to compact this material in order to improve its physical and mechanical properties, which would lead to an increase in the stability of the embankment (support).

The calculated safety factor of these partial slopes is Fs = 1.10.

The total height of the embankment (support) in the first phase should be Hg = 80 m, with a general slope angle $\alpha_g = 14^o$.

The safety factor for that slope is Fs = 1.94, with the pore pressure coefficient $r_u = 0.3$ (Figure 10).

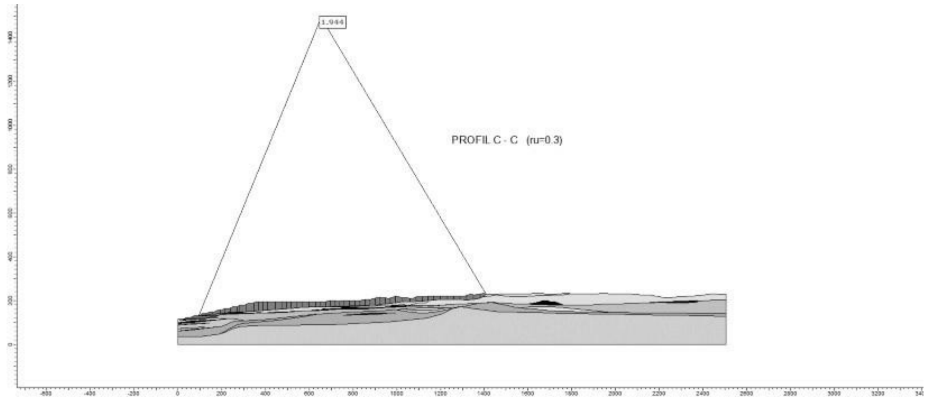

Figure 10, Safety factor (Fs=1.94) of the general slope with protective embankment (support)

CONCLUSION

The internal landfill of FIELD B/C is intended to accommodate the overburden from FIELD E, which is in the opening phase. In order for these masses to be placed in the intended space, it is necessary to prepare this space beforehand. With the pre-drainage of the entire area and the formation of a protective embankment that would support the existing deposited mass of overburden, conditions would be created for the safe opening of FIELD E and the formation of new floors at the internal landfill FIELD B / C, until the moment of transfer of the overburden to the internal landfill FIELD E. The results of the analysis of the stability of landfill slopes presented in this paper can serve as a forecast. It is necessary to investigate the entire space of the internal landfill FIELDS B/C in order that the reliability of the physical-mechanical parameters defining the disposable material should achieve the required level of reliability.

LITERATURE

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