RESEARCH TO QUANTIFY THE INFLUENCE OF LIGNITE LAYER POSITION ON THE STABILITY OF WORKING BENCHS WORK FOR OPEN PIT MINES IN OLTENIA

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Abstract

In the lignite mining activities in open pit mines, to know how the vertical position of a coal layer in a bench could influence the bench stability do allow to take the suitable decision in designing the best bench geometry

1. Introduction

Starting from the idea that the coal layer can influence the value of the stability factor (Fs) due to better geomechanical properties than both sand or clay layers that host the coal, the following analysis tried to quantify this influence on the bench stability.

The research takes into consideration different vertical positions and thicknesses of the coal layer inside a bench.

To determine and quantify this influence of the lignite layer on the bench stability, several models have been created and stability analysis have been realized using AutoCAD, GeoSlope-GeoStudio, Microsoft Excel and Surfer software.

The research was based on the case studies from the mining basin Jilt Nord and Jilt Sud.

2. Assumptions

Bench geometry. The chosen model presumes the average height of a bench 20.0 m, the lower and the upper berm width unlimited and the bench slope angle in three geometries: 45^0, 60^0 and 80^0.

Thus, in terms of geometry variations *three situations* have resulted.

Coal layer geometry (vertical position and thickness). In our model the structure of the coal layer is considered horizontal (parallel to the berms).

In the situations commonly encountered in the mining basin Jilt, the thickness of the exploitable coal layer varies usually between 1.0 m (minimum exploitable thickness) and 8.0 m (maximum thickness of the coal layer X).

For example, figure 1 shows a bench where a coal layer 8.0 m thick is located in the middle part of the bench in clays.

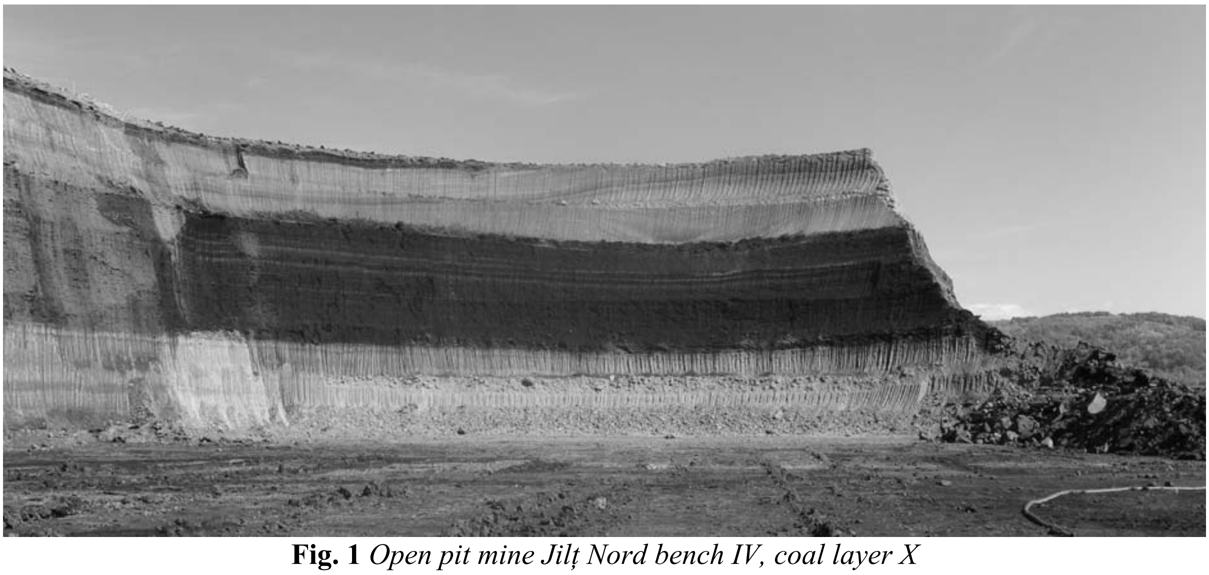

Fig. 1 *Open pit mine Jilț Nord bench IV, coal layer X*

To achieve a complete analysis, determinations for all the 8 cases of coal thickness (1m, 2m, ... 8m) have been performed.

Therewith, in order to generalize all the possible situations in the bench, the vertical position of the coal layer was considered meter by meter, from the top to the toe of the bench. Thus, in the first situation of the model, the upper coal layer is found at the upper berm level, while the lower coal layer is found at the lower berm level.

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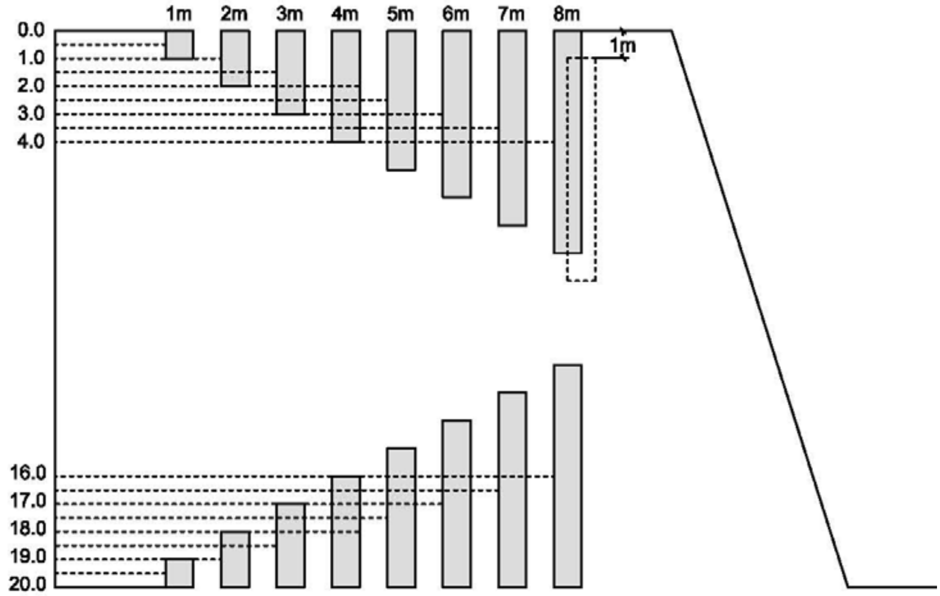

Fig. 2 *Considered situations for vertical positions and thicknesses of a coal layer*

In fig. 2 there are presented the first and last analysed positions of the middle thickness layers for all the agreed layer thicknesses. The dashed line thickness represents the next position from up to down of a coal layer 8.0.m thick. The total number of *analyzed situations was 132*.

Table 1 *Analyzed situations for different positions and thicknesses of coal layers*

Coal layer thickness [m]	Analyzed situations
1	20
2	19
3	18
4	17
5	16
6	15
7	14
8	13

Geotechnical parameters. Geotechnical parameters values used for this model were based on common values in the mining basin Jilț. Table 2 presents values of both coal and sterile rocks (clay and sand).

Table 2 *Geotechnical parameters*

Type of rock / The parameter	sand	clay	coal
γ [kN/m^3]	18	19	12.5
φ [grade]	30	25	25
c[kN/m^2]	20	50	80

In terms of geotechnical conditions *two situations* have been analyzed: the coal layer in clay and the coal layer in sand.

Seismic factor. GeoStudio program, carried out for the slope stability analysis, allows to take into account the seismic factor, by the ground horizontal acceleration. According to the normative P100 - 1/2006, the designing ground acceleration a_g = 0.12 for this mining basin area.

From this point of view *two situations* have been analyzed, with and without seismic loading, respectively.

3. Stability Analysis

All the analysis have been performed using the software GeoStudio 2004 developed by the company Canadian International Geoslope (Licence Department of Geological Engineering, Faculty of Geology and Geophysics), the module Slope/W, the "limit equilibrium" Jambu method.

Figures 3 and 4 are two examples of stability factor determination (Fs).

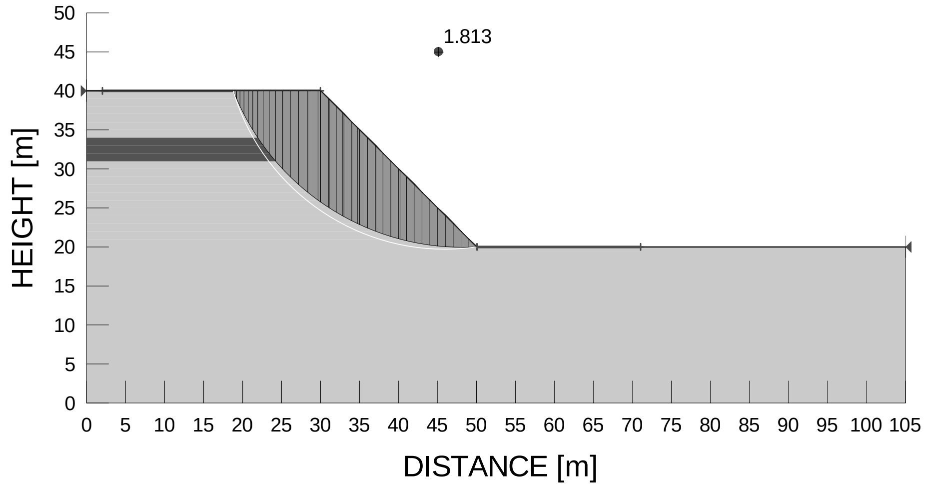

Fig. 3 - *Example 1, Stability analysis*
Working hypothesis:
• without seismic loading, slope angle 45^0, sterile represented by clay (RA)
• coal layer: 3.0 m thick, depth of the middle coal layer: 8.0 m from the top of the bench.

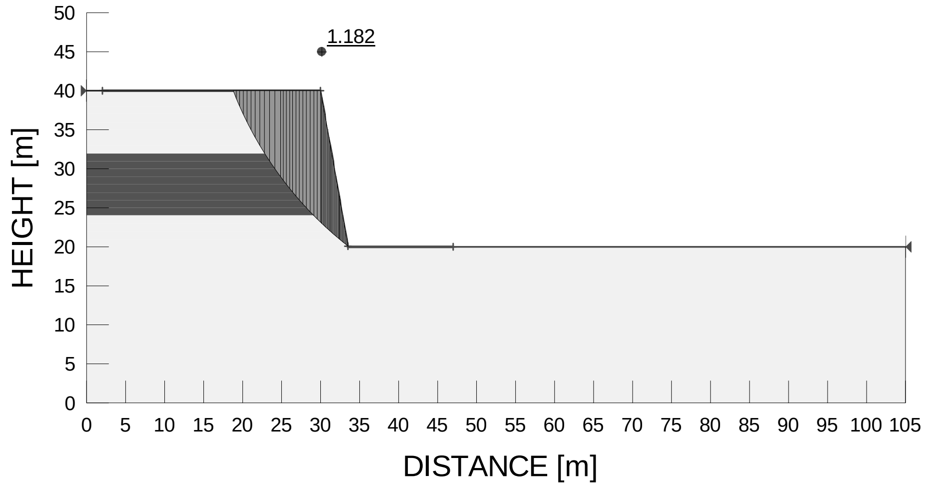

Fig. 4 - *Example 2, Stability analysis*
Working hypothesis:
• without seismic loading, slope angle 80^0, sterile represented by sand (RN)
• coal layer: 8.0 m thick; depth of the middle coal layer: 16.0 m from the top of the bench.

For a high accuracy of the results, the following stability analysis have been performed:
- 132 cases concerning vertical position and thickness of the coal layer;
- 3 cases of bench slope angle (45^0, 60^0 and 80^0);
- 2 cases of coal layer hosting rocks: clay and sand;
- 2 seismic situations: with and without seismic loading.

Thus, in total, have been analyzed:

132 x 3 x 2 x 2 = 1584 cases

4. Results

The results are summarized as diagrams "Bench and coal layer geometry – Stability factor." The Figure 5 is an example of the analysis results for a coal layer hosted in sand: *Oy* axis represents the depth of the middle coal layer from the top of the bench and the *Ox* axis represents the stability factor (Fs) for different thicknesses and depths of the coal layer (curves C1m, C2m, ... C8m).

12 such diagrams cover all the situations concerning the seismic loading, type of sterile hosting the coal layer and cases of bench slope angle.

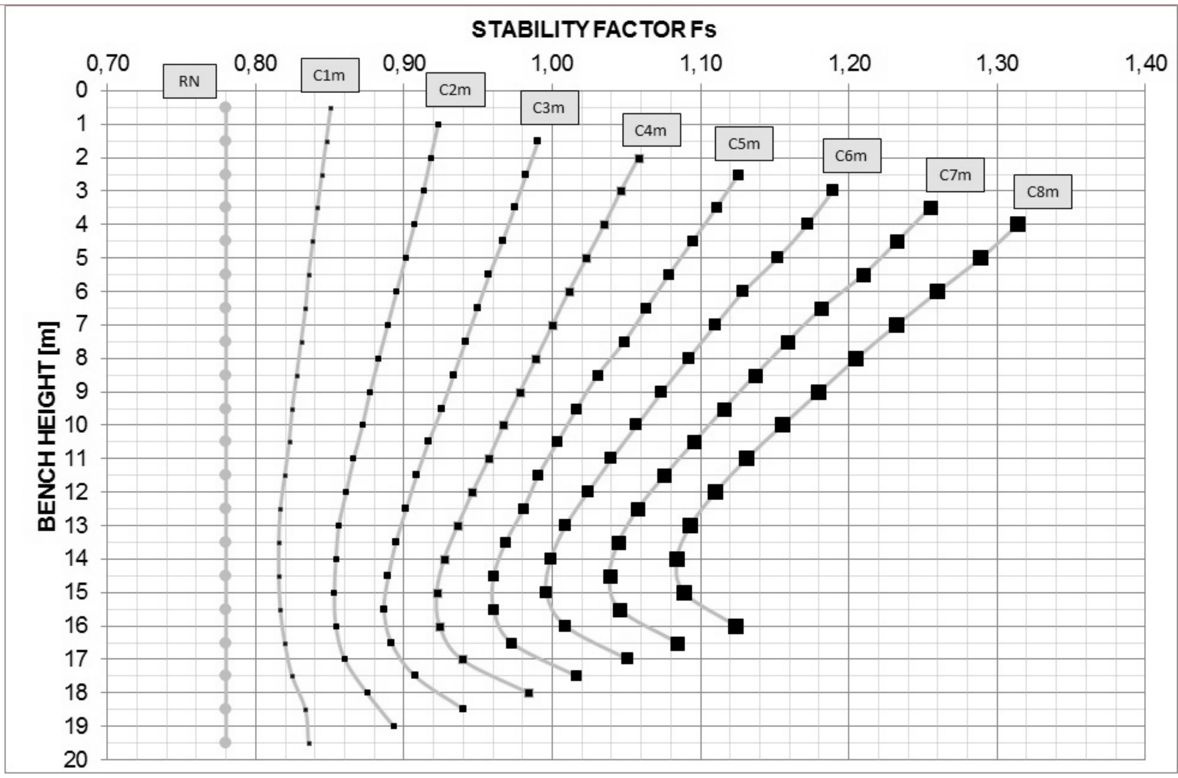

Fig. 5 - *Example diagram Coal layer geometry - Stability Factor*
(slope angle 60^0; sandy formation; no seismic loading)

5. Conclusions

The analysis of these charts leads to the following conclusions:

- The presence of a coal layer improves the bench slope stability; the higher thickness of the coal, the higher value of the stability factor (Fs);
- The variation curves of the stability factor according to vertical position of the coal layer present:
  - Maximum Fs values, when the coal layer is situated in the upper part of the bench;
  - Minimum Fs values when the coal layer is situated at the lower quarter level of the bench height;
  - Average Fs values when the coal layer is situated in the lower part of the bench;
- The Fs values are higher when the coal layer is confined by clay (RA) then by sand (RN);
- The variation interval of Fs values is larger when the coal layer is located in sand than in clay;

References

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