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DEVELOPMENT A SOFTWARE TOOL FOR MONITORING THE WATER LEVEL AT THE ASH LANDFILLS: A CASE STUDY OF KOSTOLAC, TENT B AND KOLUBARA

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Abstract

This paper presents a software tool developed for drawing the water level lines on the ash landfills, with the aim of improving the accuracy and efficiency of processing the field measurements. The tool enables an automatic generation of graphic displays, based on data entered in the Excel tables and opening the DWG files for analysis. The methodology used includes the integration of Excel and AutoCAD platforms for more efficient data analysis. The results show a significant reduction in processing time and an increase in accuracy. It was concluded that the tool can significantly improve the monitoring of auscultation at the ash landfills.

Keywords: *software tool, auscultation, level line, ash landfill, automation*

1. INTRODUCTION

The ash landfills are important infrastructural facilities in the energy industry, where ash and slag produced by coal burning in the thermal power plants are deposited. Due to possible environmental impacts, these landfills often occupy the large areas and represent a significant challenge for maintenance. In addition to being a risk for the air and water pollution, the ash landfills require the strict controls to prevent erosion, leaching of contaminants into groundwater, and stability of the landfills themselves. One of the most important things in this process is monitoring the groundwater level, which directly affects the stability of landfills [1].

A software tool was developed that was designed to work with data from Excel tables containing the results of the field water level measurements. The users enter data from observations directly into the program, which then automatically generates the graphical representations of water levels for the piezometric landfill profiles. The tool is currently set to work at the ash landfill in Kostolac, TENT B and Kolubara, but it can be adapted for other locations as well. Application of this tool has led to the significant improvements in data processing and accuracy of results, enabling easier interpretation of information and faster decision-making related to the landfill management. Due to these advantages, the tool is a valuable tool for engineers and other professionals involved in auscultation of the ash landfills. The users can perform tasks without the need for advanced technical knowledge, which reduces the time required for training and allows for wider application of the program.

1.1 The Existing Method of Creating the Graphic Representations of Piezometer Profiles

The current method of creating the graphic representations for piezometric profiles requires a series of specific steps. Data on water depth are most often determined using the

water sensors with a probe. The probe water sensors are simple devices that use a probe attached to the measuring tapes [2]. The probe is lowered into the piezometer until it contacts the water, which is an indication of change in the electrical resistance in the probe. When the probe detects water, an audible signal is activated, and the depth measurement is read on the measuring tape. First, water level measurements are collected from the field, which are then entered into Excel. Then, based on these data, the water level lines and depth values of each piezometer are drawn using AutoCAD. The water level lines are drawn manually, connecting the points representing measurements at different piezometers. This process is the time-consuming and requires a high level of concentration to avoid errors, especially for more complex profiles with several piezometers.

1.2 Functionality and Performance of Developed Program for Automation the Graphic Drawings

With development and application the software tool for drawing the water level lines on the ash landfills, the process has been significantly improved compared to the manual work methods. The program enables the automatic drawing of a large number of profile lines with higher speed and minimal possibility of error. It was developed using the different programming languages, with a special emphasis on easy installation and ability to add the new projects and modules to work with data for three specific landfills. The modular structure allows an easy program expansion, while the intuitive user interface facilitates working with different data sets.

In order to use the program, it is necessary that the user has installed AutoCAD and MS Office Excel. The users can easily open Excel and DWG files, draw level lines directly on profiles and save results in DWG format (Figure 1).

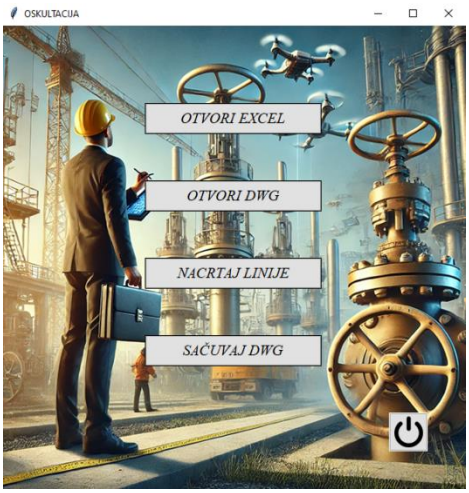

Figure 1. *Main program interface*

Figure 2. *"Open Excel" field interface*

2. OPEN EXCEL

When starting the "Open Excel" option, the program offers the possibility of entering data from the field measurements into already existing Excel tables for the ash landfills in Kostolac, TENT B and Kolubara (Figure 2), as well as creating the new projects. The users can easily add the new water level data or create entirely the new Excel spreadsheets using the "New Project.xlsx" option, which allows data entry for other landfills.

3. OPEN DWG

The "Open DWG" option allows users to view and work with DWG files for the ash landfills that were the subject of the study, which allows the precise modifications and data updates (Figure 3). The drawings contain the longitudinal sections with the exact geodetic position of the piezometers and field line. The users can review, analyze and make changes to the drawings, which is especially useful in case of terrain changes or addition the new piezometers. Also, there is an option to create the new projects starting the "New project.dwg" field, allowing customization and extension of the program.

Figure 3. *"Open DWG" field interface*

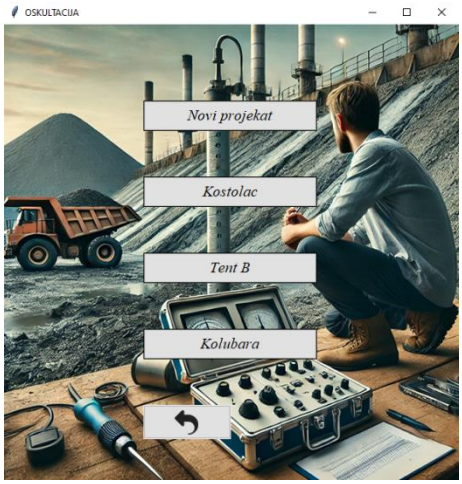

Figure 4. *"Draw Lines" field interface*

4. DRAW LINES

The "Draw Lines" feature allows users to draw the water level lines on piezometer profiles, with an automatic printout of water depth in piezometers (Figure 4). This process significantly speeds up work compared to the manual drawing, allowing automatic drawing of more profile lines. Figure 5 shows an example of a profile where the water level line is drawn in blue, clearly showing its position along the profile. The line is created based on the field measurements entered into Excel, which calculates the groundwater level for each piezometer. The water depths are also shown, numerically marked below each point, allowing engineers to quickly spot changes.

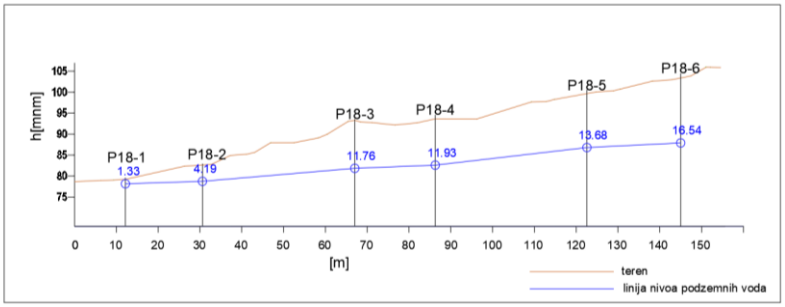

Figure 5. *Example of a profile generated by the program*

5. SAVE DWG

The users can save a DWG file with the option of choosing a location as well as a desired file name. This option provides flexibility to the users to organize their projects in a way that suits them best, facilitating later access and further processing of data.

6. CONCLUSIONS

Directions for Future Research and Program Improvement

In order to further improve the program capabilities and facilitate the work of engineers, the goal is to develop the program in the following directions:

- **Connection to the electronic piezometers:** It is planned to connect the program to the electronic piezometers to enable the collection of more accurate and reliable data. This integration will enable monitoring the water level on a daily basis without the need to go out into the field, which significantly improves monitoring. Data will be available at all times. Until the program connection of the program with electronic piezometers is ensured, it is necessary to increase the quality and accuracy of input data from the field.
- **Database of previous annual reports:** The database implementation that will contain previous annual reports is also planned. This database will have limited access, which will ensure the data security and privacy. Previous reports are of key importance for better monitoring the state of landfills and familiarizing engineers with the specifics of the terrain they are working on.

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