ABSTRACT

Opencast mining is the most efficient and highly productive mining method. This method is associated with a challenge of handling huge amount of overburden waste material in a form of dump slope. In mega opencast projects dragline is used in combination with shovel-dumper combination, which side-cast the overburden just above the coal seam and forms a dragline dump. The increasing demand of coal is forcing mining operations to go deeper and to handle more overburden material in form of dragline dump slopes. Due to this ensuring the stability of dragline dump slope has become a main challenge in front of engineers, as it lies close to the working face. Stability of dragline dump slope is essential for safety of men and machinery along with economic extraction of the mineral. Stability of dragline dump slope primarily depends on the grain size distribution, geo-mechanical properties of the overburden material and the geometrical parameters of the dragline dump.

Various researches have been done for the analysis of the dragline dumps, but they are mostly based on limit equilibrium method and the variability involved in the geo-mechanical properties have not been incorporated. In this study, stability analysis has been performed using finite element method and it also has incorporated the variability of the geo-mechanical properties using Monte Carlo simulation method. On the basis of the analysis a safety chart is proposed for quick identification of the stability of the dragline dump slope. The chart has been devised by using three most sensitive geometrical parameters (Slope angle and the Height of the dump which is below the dragline sitting level and Coal-rib height) and the variability of geo-mechanical parameter has already been included into the simulation. The proposed safety chart has been validated by the previous research studies. This chart can be used by the engineers to

easily identify the stability state of the dragline dump slope as well as can also assist them for a stable construction of the dragline dump slope. The safety chart is categorized into three zones; fail, vulnerable, and safe. This chart can help in focusing more on the vulnerable slopes.

After proposing a safety chart which is feasible to three critical geometrical parameters, a classification system has been formulated including all geometrical and strength parameters, using the numerical simulation data which is based on the finite element method. The sensitivity analysis of various geometrical and strength parameters of the dragline dump slope is performed using the data of the simulation results. The two-factor interaction method is also incorporated in the sensitivity analysis; it includes the dependency of the closest parameters while calculating the sensitivity index, and thereafter, which is converted into rating of each parameter. The highest rating value is given to the strength parameter, such as the angle of friction, and the geometrical parameter, such as the slope angle of the bench between the coal-rib roof and dragline seating level. The stability of dragline dump slopes is classified into several groups, including very safe, safe, vulnerable, unstable, and highly unstable, based on the overall rating. This classification system is useful in quick estimation of the stability of the dragline dump slope along with this it also suggests in designing the safe dragline dump profile by carrying the optimum volume of overburden material. It has been validated by the previous research works.

An Artificial Neural Network model is formulated and a Multiple Regression Analysis method is used to forecast the factor of safety of the dragline dump slope using the numerical simulation data. Two datasets are used; simulation data used in safety chart and the stability classification of the dragline dump slope. The results of the numerical

simulation of the dump slope models were contrasted with the expected outcomes produced from the Multiple Regression Analysis and Artificial Neural Network models. Additionally, a number of performance metrics, including variance account for (VAF), determination coefficient (R2), root mean square error (RMSE), and residual error were calculated to assess the validity of the two models. The Artificial Neural Network model has demonstrated a greater prediction accuracy than the Multiple Regression Analysis model based on these performance indicators. The research finds that the Artificial Neural Network model created in this study may be useful in designing the safe dragline dump slopes at an early stage.

Keywords: Dragline Dumps, Finite Element Method, Monte-Carlo simulation, Safety chart.