Detection of Appropriate Groundwater Lowering Approach in Open Pit Mines: A Case Study of Sechahoun Iron Mine of Iran

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ABSTRACT

An increased demand for useful minerals, exhaustion of shallow-bedded resources, and development of machinery, enabling surface mining to be run deeper and deeper are a reason that the dewatering becomes a necessary condition for extraction in ever increasing number of operations. From the viewpoint of the necessity of dewatering and method of dewatering, several types of dewatering can be distinguished for surface mining operations. In such a situation, a dilemma arises to detect most suitable method of dewatering assuming technical applicability, economic efficiency environmental protection and so on. This paper being an attempt to develop a new decision support system based on fuzzy multi attribute decision-making method. An applied case study drawn from Sechahoun open pit iron mine of Iran is used to demonstrate and test findings. The proposed methods systematically evaluate alternatives, with the result indicating promise for solving a dewatering system detection problem.

Keywords: Groundwater Lowering Program (GWLP), Open Pit Mining, Decision Support System.

INTRODUCTION

One of the major practical difficulties often associated with mining operation is related to groundwater. Whenever a mine is operated below the water table, water inflow occurs from the surrounding layers towards the mining excavation. The presence of groundwater can affect open pit mine excavations in two ways. First, it can change the effective stress and resulting pore pressures exerted on the rock mass into which the pit slopes have been excavated. Increased pore pressures will reduce the shear strength of the rock mass, increasing the likelihood of slope failures and potentially leading to slope flattening or other remedial measures to compensate for the reduced overall rock mass strength (Beale 2009). Second, it can create saturated conditions and lead to standing water within the pit, which may result in: loss of access to all or parts of the working mine area; greater use of explosives, or the use of special explosives and increased explosive failures due to wet blast holes; increased equipment wear and inefficient loading; increased damage to tyres and inefficient hauling; and unsafe working conditions (Morton & van Mekerk 1993).

Groundwater will flow into the open excavation until the former water levels are achieved and the original groundwater flow regime is re-established (Brassington 2007). Hence, all mines that are excavated below the water table need some form of groundwater lowering programs (GWLPs). The scale of the GWLP depends on the three factors: the hydrogeological characteristics of the rock mass in which the excavation takes place; the depth of the excavation below the water table; and the strength of the materials making up the pit slopes. At some mines excavated below the water table, evaporation of minor groundwater seepage from the pit floor or pit walls in a strong and stable rock mass can take care of all GWLP requirements. At other mines, major pumping operations are necessary, using external wells to control groundwater inflow to the pit and to lower the pore pressure in the rocks making up the pit slopes.

In some instances, the decision to implement a mine GWLP can be made based on projected savings in operating or equipment maintenance costs alone (Beale 2009). An example is the mine dewatering program for the Morenci mine Metcalf pit in Arizona (Table 1). The Table illustrates only operating costs for a given mine design. In this example, the potential economic benefit of a depressurized and steeper wall was not considered in the cost-benefit analysis.

Table 1. Example of operating cost savings due to dewatering (Beale 2009).

Cost element	Benefit ($/yr)
Savings in blasting costs	398 000
Reduced slope maintenance	960 000
Reduced operation of in-pit sumps	164 000
Savings in haulage costs	709 000