

The Role of Mine Surveying Studies in Preventing Probable Risks that might be emerged in Open Pit Mining Projects

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ABSTRACT

In order to extract mine from the ground in any area, the type of mining to be selected will able to be defined as the result of the pre-investigations and analysis in the intended area. At this stage, economic value of the ore, geologic and tectonic features of the mining field, topographic state of the field, the thickness of the ore and the earth layer that is covering the ore, the excavation ability of the earth, and climate conditions of the concerned area are the leading factors in defining the type of mining (underground mining or open pit mining). In the later stage, these criteria, will be affecting and differentiate the mine measuring activities to be applied on the field, depending on the type of mining that is decided for application on the field. In this study, it is attempted to define the possible field measurement studies that are in the scope of mine surveying and probable risks that might be encountered in case of lacking these activities, during the starting, implementing and finishing the mining activities that are defined in a selected open pit mining area.

Key Words: Open Pit Mining, Mine Surveying, Engineering Measurements, Mining Measurements

1. INTRODUCTION

To find out the fact that mining activities will be realized or not in a certain area, will able to be understood as the result of field drilling and the mapping for these drilling, definition of mine ore range and geometry, obtaining the ceiling and floor contour lines mapping, generating the isopach maps for mine ore and earth layer, explaining the topographic situation and assessment of reserve calculations and analysis [1].

In the later stage of realized activities, economic value of the ore, its situation in the earth, and ore geometry will be obtained, hence this result also enables to define the type of mining. In the above defined all kind of activities, we would need mapping, plans and surveying studies, and in order to make these studies we also need sensitive engineering measurements by utilizing geodetic techniques (GPS, Total station etc...) aerial photographs, remote sensing and Lidar (Light Detection and Ranging) techniques [1,2,3,4,8,9]. Furthermore, as the result of above defined studies, various factors must be taken into consideration and care to be taken in order to define the suitable mining type for the ore mass that its situation in the ground, shape, and economic value has been identified in advance. For the underground or open pit mining type that is considered to operate in a mining field, the following criteria will be very important [1];

- Ore and overburden thickness and amount
- Excavability of overburden on ore

- Economic value of ore
- Tectonic features of mining field
- Updated topographic status of mining field,
- Over ground field usage activities and their features in mining field,
- Economic value of mining field,
- Operation facilities in hand and climatic features of the field,
- Stripping ratios for the field that mining activities will be carried out

After defining those elements on the field with the aid of realized field pre-investigation and observations, if open pit mining is chosen on the field, overburden excavation preliminary project preparation will be required. In preparation stage of an overburden excavation preliminary project, realization of the following mine surveying activities will be suitable in terms of field surveying and measurement activities;

- Calculation of overburden excavation amount via topographic map,
- Calculation of reserve amount that will be equivalent with overburden excavation,
- Definition of geometry for the field and the slopes during the excavation and post excavation stage and identifying measurement monitoring periods,
- Definition of soil storage areas and their capacities,
- Definition of the in mine road and out mine road routes and making geometric calculations and preparing their design projects,
- Definition of the required fields for open pit mining and its relevant facilities
- Provision of property rights relevant gains for those defined fields,
- Preparation of infrastructure projects for planning and measurements of open pit mining investments (for example preparation of design projects for the buildings, facilities, infrastructures and roads that belong to working personnel)

In case of failure to realize the measurement and planning activities in above mentioned project stages, it is more likely to encounter with negative vital results in mining activities such as; enduring high cost, unsafe for working safety conditions, improper progress of the project...etc. [5,6,7]. In the following Figure1, important aspects for a mining field geometry are given in sectional view in terms of measurement activities.

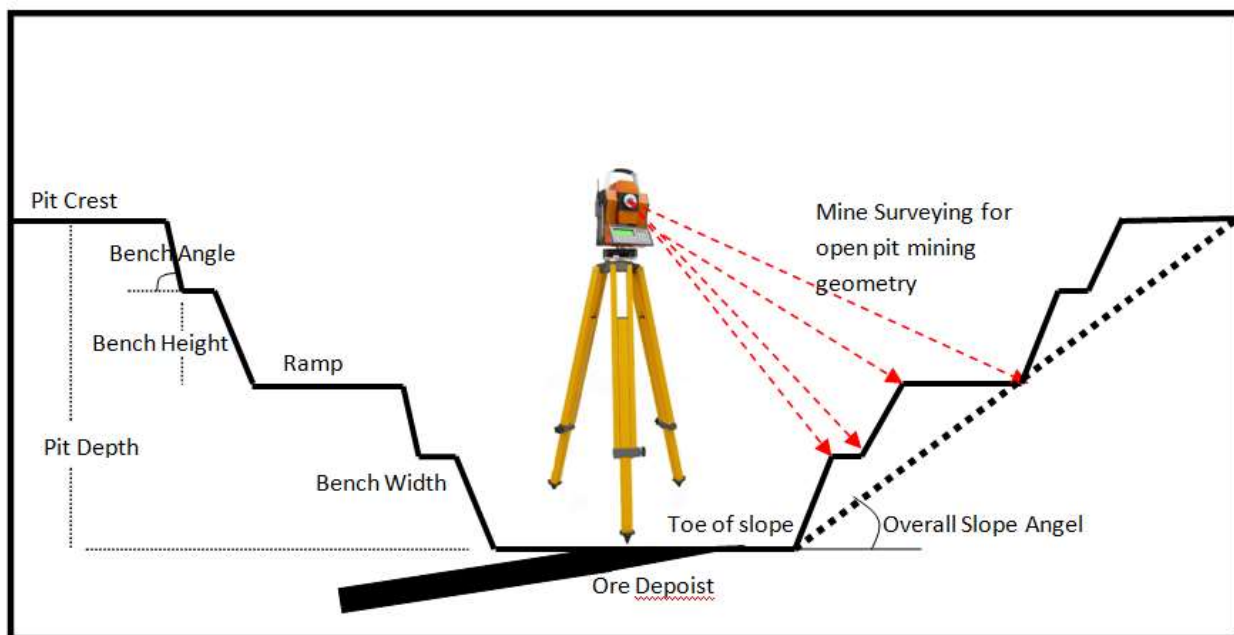


Figure 1 Sectional View of an Open Pit Mining With Regard to Measurement Activity Elements.

2. THE MINE SURVEYING DUTIES IN AN OPEN PIT MINING DURING THE START UP PERIOD

To sustain the implementation activities in a open pit mining as per the existing project will be proportional with the proper and sensitive handling of mine surveying activities. Proper measurement, calculation and establishment of geodetic terrestrial measurement control network in the mining field are the primarily needed activities that are required in terms of mine surveying in the relevant mine field. In Figure 2 schematic view is given in an open pit mining for geodetic terrestrial measurement network.

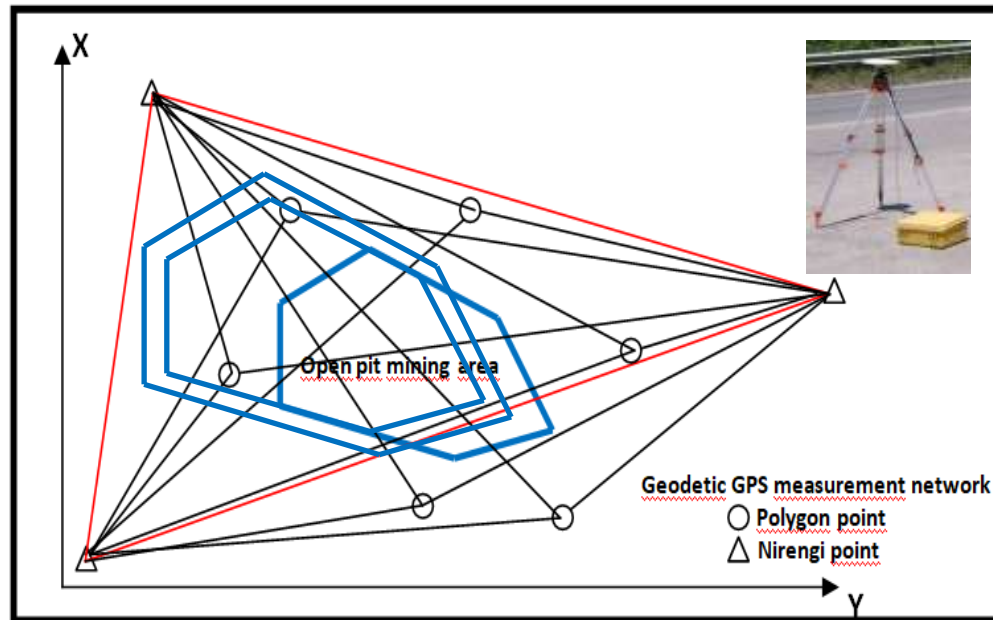


Figure 2 Schematic View for A Geodetic Measurement Network in An Open Pit Mining.

Furthermore, to meet the mapping and plan needs for the field and process on the maps in an updated manner remains among important mine surveying activities. As per the progress of the implemented field activities, expropriation of the needed fields and preparation of expropriation plans will be required. Hence, as the implementation works progress in the open pit mining the application or implementation of previously prepared preliminary projects, and all kinds of project appendixes into field and controlling this application carries prime importance.

At this stage;

- Application works for property and utilization rights obtained project fields,
- Application works for excavation and soil storage fields,
- Application of slope geometry into the field during the overburden excavation (bench width, slope angle, slope high, overall excavation slope angle,...etc),
- Application works relevant to mine roads and various structures

Implementations as defined above, (carried out of field applications) are the important duties of mine surveying as shown in Figure 3 [1]. Furthermore, in the open pit mining, revealing of topographic structure of the field prior to excavation works and 3-D generation of terrain elevation models (DTM), and repeating these measurement studies in the later stage of the excavations to be made in the mine field in certain periods will be required with regard to following issues[10];

- Ore extracting and soil excavation with field production,
- Accurate calculations of progress payment,
- To reveal the topographic changes on the field

Realization of above defined mine surveying activities in an open pit mine during the start up period, facilitates the works to progress on time and healthy manner as well as provides proper precautions for prevention of probable future risks such as; miscalculation, working safety, delay in time, over-cost,...etc.

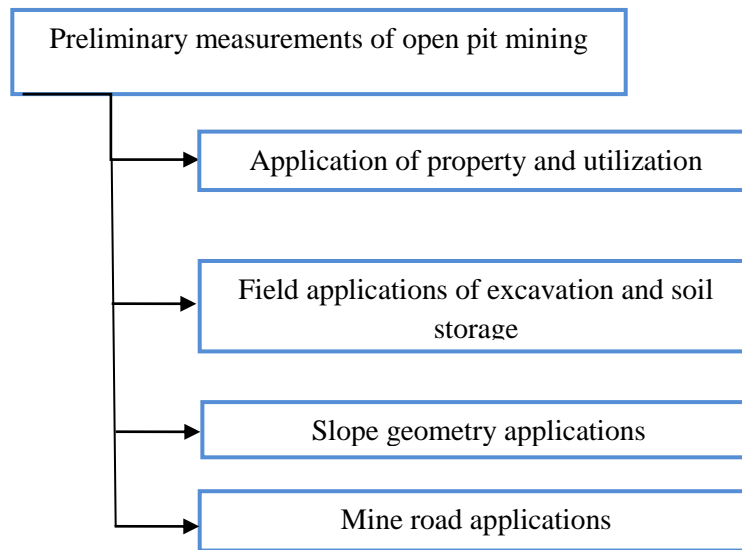


Figure 3 Mine surveying duties in preliminary measurements in open pit mining

3. MINE SURVEYING DUTIES DURING THE CARRYING OUT OF WORKS IN AN OPEN PIT MINING

In open pit mining, during the ore extracting activities, there are many important points and engineering measurement issues relevant to mine surveying and mine field. In order to make those measurements in an accurate, sensitive and precise manner will affect the coordinates/coordinate areas, areas/volumes, volumes/progress payments. Mainly needed topographic works on the field while overburden excavation and ore excavation is in progress, can be cited as [1];figure 4

- Measurement and calculation of excavation and storage cubage in certain periods,
- Drawing of cross sections for cubage calculation,
- On time and accurate processing of these works, measurements and topographic changes that have taken place on the field onto relevant plans,
- Field control measurements in order to maintain the excavation and batch areas to remain in the defined field and complying the slope, elevation and situation as per the Project,
- To make slope follow up measurements, in order to prevent slope stability and/or landslide problems in advance in mine field and taking important precautionary means for working safety,
- Preparation of end of year activity reports and appendixes,
- Measurement activities to be made toward probable deformations in big mobile working machines such as excavator, loader,...etc. that are operated in open pit mining,
- Calculation of situation and application coordinate values for drilling wells to be opened in order to reduce the underground water table level into a certain elevation in the excavation field, and application measurements

In order to make the above defined mine surveying field measurements in an accurate, sensitive and timely manner will be depending on the geodetic terrestrial network that is established in the field again in an accurate and sensitive manner. During the works in open pit mining; field measurements, calculations, and relevant documents have an important place that have to be included in the required reports and data that must be submitted to the formal/official authorities. Hence, this fact increases the importance of accuracy and sensitivity in the measurements that are realized in the above defined works. Likewise, as per the progresses to be made in the activities in mine fields, the purchasing of the fields that are needed by open pit mining, providing their expropriating, defining utilization rights, ...etc type similar legal issues also take part in mine surveying implementation scope. In an open pit mining, during the implementation of works, realization of above defined mine surveying activities, will

enable to make healthy and timely progress of the works as well as it will prevent emerging future probable risks such as; miscalculation, working safety, delay in time, over cost, ...etc

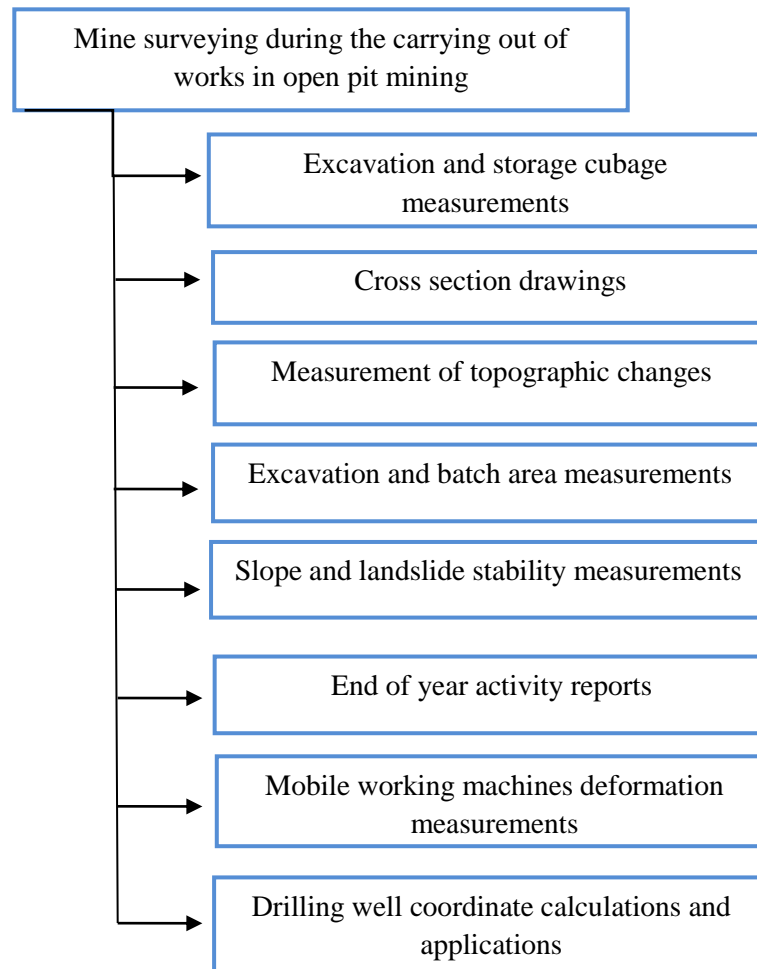


Figure 4 Mine surveying Duties during the carrying out of works in open pit mining

4. MINE SURVEYING DUTIES IN THE FINAL STAGE OF THE WORKS IN AN OPEN PIT MINING

In cases of an open pit mine activity ending or stopping the activities due to various reasons, preparation of the most updated plan of the field, cross sectional view, ..etc similar graphical documents and formation of 3D digital elevation model of the field becoming very important. In order to make the above defined works, sensitive measurements that are made over geodetic network that is formed with high accuracy in the field, carries great importance.

In addition to the above defined works, amount of excavation that is made in the open pit mining area, amount of transportation, and amount of mass in the batch area have to be known definitely. The most important aspect in that sense, whatever measurement method, equipment and devices are used at the beginning of the work, could also be very useful to use at the final stage of the work. The main mine surveying activities at this stage can be cited as;

- Establishment and application of geodetic measurement networks for detail measurements in the field during final acceptance and definition of coordinates and heights,
- Measurement and calculation of detail coordinates and heights, in order to define the final position of excavation and batch areas in the field,
- Preparation of final acceptance and making cross sectional measurements,
- Preparing drawings of cross sectional views for cubage calculations in computer,
- Making area and cubage calculations over these cross sections [1].

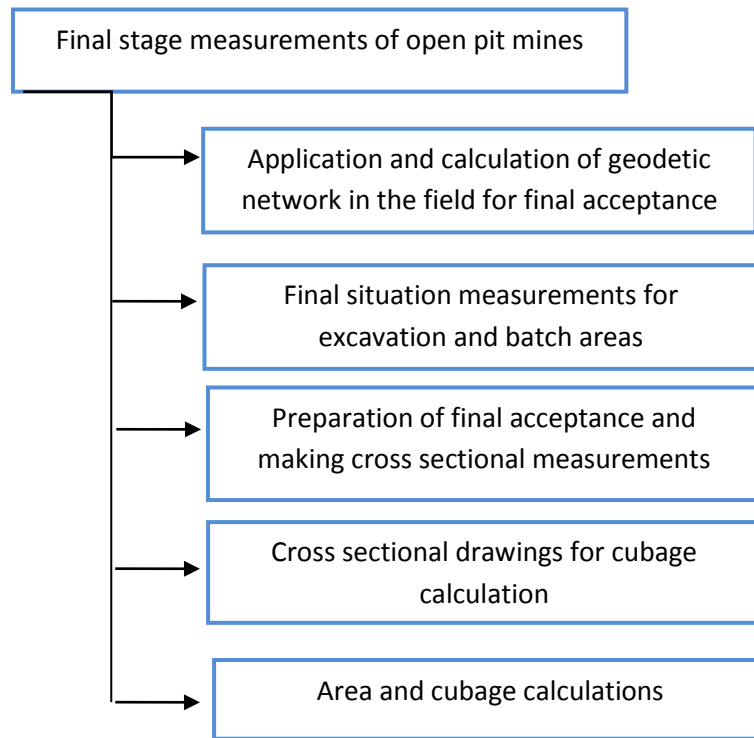


Figure 5 Mine Surveying Duties During Final Stage Works in Open Pit Mines.

In the Figure 5, realization of above defined activity steps of mine surveying during final stage of the works in an open pit mine, will provide to make healthy and timely progress of the works as well as it will prevent emerging future probable risks such as; miscalculation, working safety, delay in time, over cost,...etc.

8. RESULTS

In the open pit mine implementation fields, mine surveying activities made in the field from operation start up to the end of activities carry great importance. Especially, in definition of overburden excavation and extracted ore amounts, and in estimating the economic value of this defined mass, and for avoiding economic losses, field measurement works that are in the scope of the mine surveying are needed to a great extent.

Furthermore, in the overburden excavation and ore excavation works in these kind of operations that are made in substantial amounts, in order to calculate the amounts in an accurate and sensitive manner will be depending on the sensitivity and accuracy of the field measurements and geodetic network that is established in the field. Likewise, in rehabilitation of the fields in post mining period, mine surveying activities are needed in equal importance

By performing above defined measurements, while the progress of the works is maintained in a timely and healthy manner, as well as, emerging of future probable risks such as; miscalculation, working safety, delay in time, over cost,...etc. will also be prevented. Hence, training and awareness of the technical personnel will also be very important, since they perform such important mine surveying activities, measurements and calculations.

It is also important that, mine surveying engineers to be employed in these fields might follow up the most recent technological advancements in measurement field along side with their basic higher education. That will provide benefit both the mining owners and the society.

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