EVALUATION OF COMPUTER-AIDED 3D DESIGN OF OPEN PIT MINING

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ABSTRACT

Mines should be produced in accordance with the modern mining science and technology. It is only possible by using a mine design software which produces realistic production model and design. In this study, realization of the computer-aided 3-dimensional open pit designs, adapting them at actual mine sites and evaluating the results by using different designs will be analyzed.

Pit and waste dumps designs are generated both manually or automatically by using the software. Thus, it is possible to evaluate alternative pit designs in a short time. Productions carried out without proper mine design and planning may lead to loss of resources.

In Turkey, the need for a scientific and rational use of natural resources is increasing in parallel with the growth of mining industry. Computer Aided 3D mine design must be widely carried out for enabling effective and efficient use of resources.

BİLGİSAYAR DESTEKLİ 3 BOYUTLU AÇIK OCAK TASARIMLARININ DEĞERLENDİRİLMESİ

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ÖZET

Madenleri çağdaş madencilik bilim ve teknolojisine uygun bir şekilde üretmek gerekir. Bu ise gerçekçi bir üretim modellemesi ve tasarımı gerçekleştiren yazılımlarla mümkündür. Bu çalışmada değerlendirilecek kısım, Bilgisayar destekli olarak 3 boyutlu açık ocak tasarımlarının yapılması, hızlı bir şekilde yetkin tasarımların sahaya adapte edilmesi, farklı ocak tasarımları arasında sonuçların değerlendirilmesidir.

Yazılım ile üretilen ocak ve pasa harman tasarımlarının gerek kullanıcı tanımlı gerek otomatik olarak oluşması sağlanmaktadır. Böylece pek çok ocak alternatifini hızlı bir şekilde değerlendirmek mümkün olmaktadır. Düzgün bir tasarım ve planlama ile yapılmayan üretim sonucu kaynaklar kullanılamaz hale gelmektedir

Türkiye'de madencilik endüstrisinin büyümesine paralel olarak kaynakların daha bilimsel ve rasyonel bir şekilde kullanılmasına duyulan gereksinim artmaktadır. Ülke madenlerimizin etkin ve verimli kullanılması açısından bu tekniklerin kullanılması bir zorunluluktur.

1. INTRODUCTION

In our country, the production of mineral resources according to the modern mining, science and technology has gained importance due to mineral prices. In parallel with the growth of the mining industry, the need for more scientific and rational use of resources is increasing. When our mines are efficiently operated, they have the potential to make a serious contribution to the economy.

Computer-aided orebody modeling and mine designs have also started to be utilized widely by private sector companies and public institutions.

Computer-aided automation of mining sites can be evaluated in two aspects: modellings and designs. The modelling subtopic can be considered as the modeling of orebody, faults, seam structures, interburden or geology. The designs subtopic includes the design processes, which aim to plan the mining area in an optimum way, such as gallery designs, open pit designs.

The proper modeling processes directly affects the accuracy of the advancing processes and the future of the studies.

Computer-aided designs provide more reliable and faster results in the management of mining production and especially in decision support processes.

Determination of the parameters like ramps that are the part of the surface mining operations, road designs, gallery designs that are related to the underground mines and ventilation calculations are important for the computer-aided designs.

In this study, composing of computer-aided 3D designs of new topography, bench and slope during the open pit work in the Tunçbilek lignite field are evaluated. Open pit designs have been carried out with NETPRO/Mine mining automation and design software.

2. FIELD MODELLING

After the modeling of open-pit projects, performing a mine design considering the grade and quantity expectations of the mine increases the sustainibility and profitability of the production.

An important problem in the economic and technical evaluation of lignite reserves is the estimation of lignite quality-reserve curves and evaluation of the uncertainty of these estimations (Tercan, and Akcan, 2005).

With NETPRO/Mine software, it is aimed to increase the efficiency, to save time and to perform the designs more quickly and accurately according to mine production data. Users have a need of special software tools for this purpose. Advanced, professional and user-friendly software tools are needed to perform the modelling and design processes related to mining in an integrated structure.

Simulation is the model of reality, and geostatistical simulation aims to produce values in such a way as to retrieve certain properties of existing data. If the simulation values have the same histogram and the same variogram as the existing data, the simulation method is called unconditional simulation, in addition of these if it is the same as the values in the existing data points is called conditional simulation (Tercan, Hindistan and Ünver, 2012).

In addition to drilling data, outcrop samples taken from the surface and their readings, bed dip and strike, faults, underground gallery surveys, geophysical surveys and research pits provide information to the modeling process and enable accurate modeling. The correct realization of the modeling can be achieved by presenting the information in a proper composition using each information in a manner that supports each other.

The field that is subject of the study is located in the north of Tunçbilek in the Domaniç district of Kütahya province. Figure 1 shows the location map of the study area where lignite production continues.

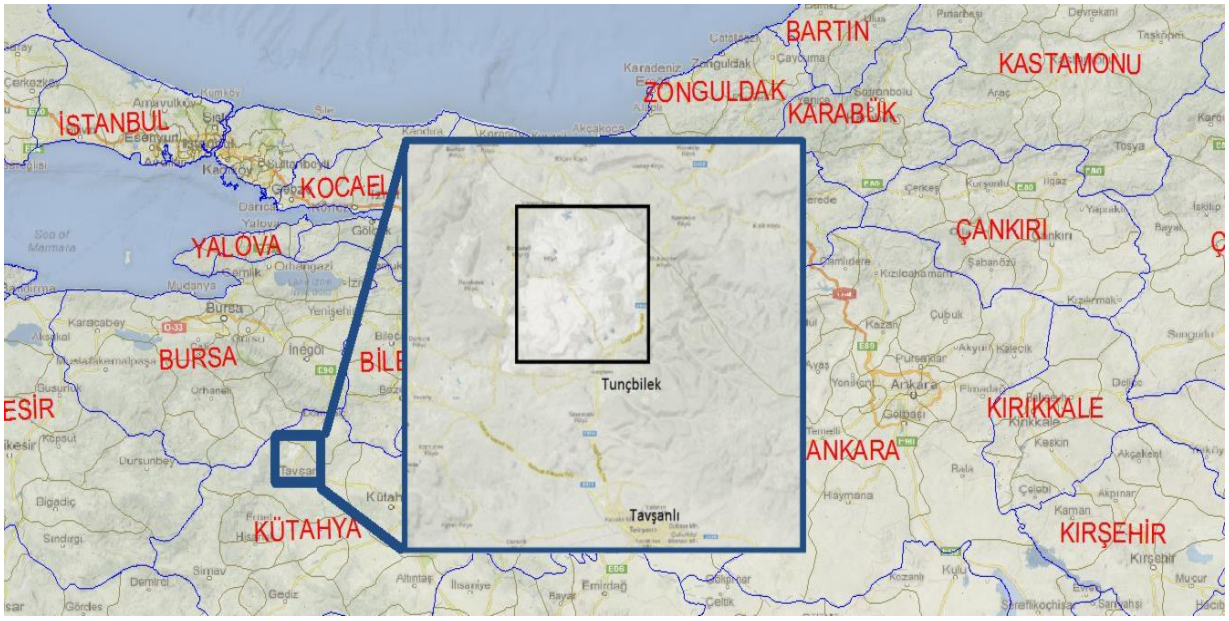

Figure 1. Location map of the study area

To mention the geology of the region very shortly, Domaniç, Tavşanlı, Kütahya and Gediz volcanic and sedimentary Tertiary sediments are unconformably and extensively overlie the older units. Between Tavşanlı and Tunçbilek in the south of the region late Eocene limestones and throughout the region late Miocene volcanic rocks are found (Pekmezciler, 1955).

A database has been created in the NETPRO/Mine software by using the data from the region. Compositing operation is the operation that most affects the modeling processes in this database. Producing the composites in a way that accurately represents the field allows for a prediction on the field. Scattering diagrams and histograms are produced after the compositing process (Figure 2-3). These graphs form the basis of the preliminary evaluation for the field.

Calorific value, ash and sulfur content are considered as lignite quality variables.

The sequential normal (Gaussian) simulation method has been used as the simulation method. In the next part of the study, the details about the design subtopic are given.

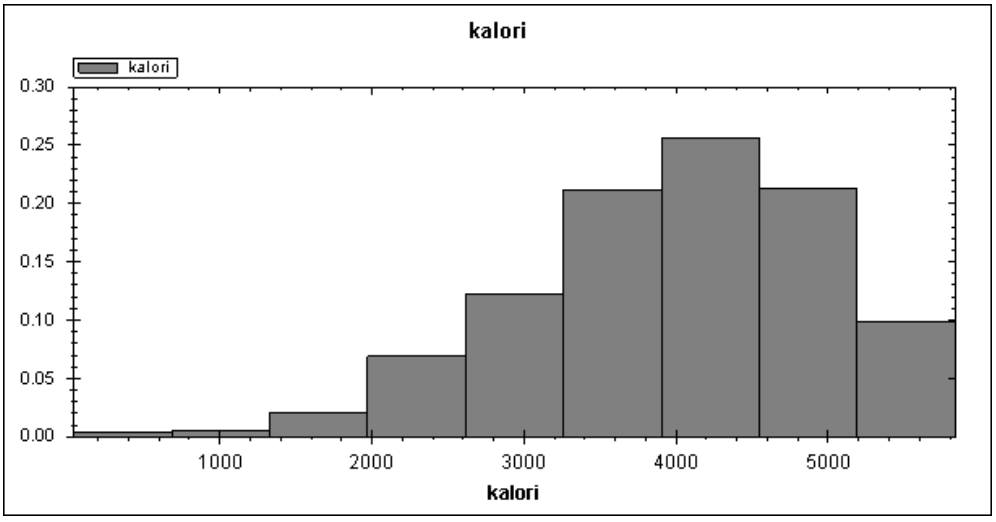

Figure 2. Sample histogram graph of lignite coal samples

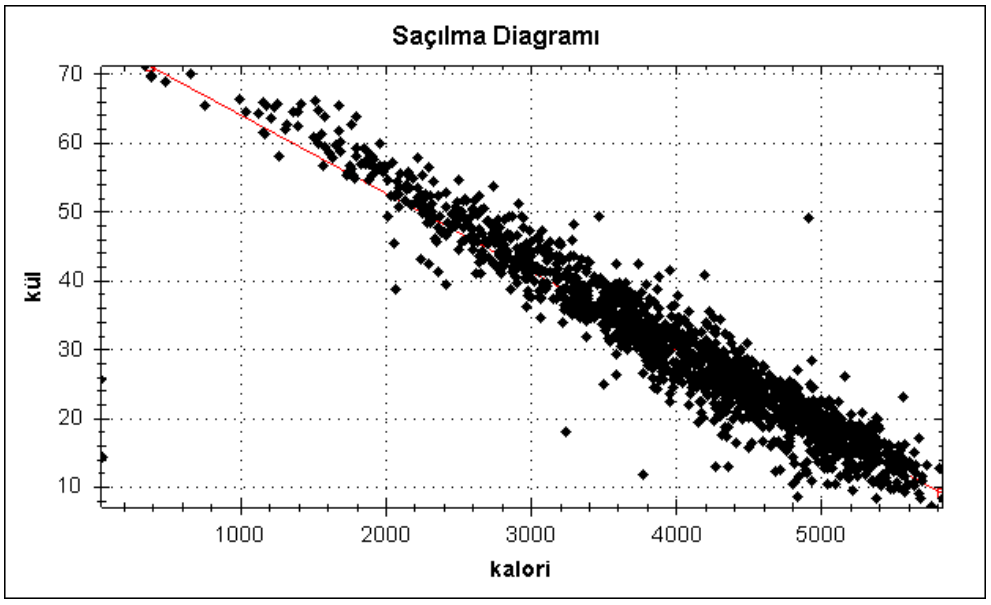

Figure 3. Sample scatter diagram of lignite coal samples

The digital elevation model of the field is combined with the drill hole database by using NETPRO/Mine software. Prior to creating block model, composites have been produced from the drill hole data. Thus, the sample sizes taken from the lignite coal have been equalized and brought to the same weighted average to use in the geostatistical calculations. In the compositing process, composites have been produced by accepting the composite range as higher than the average core length.

In order to model the mine site, a solid model is formed, and the orebody is divided into blocks. After the blocks are separated, the most important part is the assigning values to the blocks by using the estimation method that shows the ore distribution best. The appropriate geostatistical method will ensure realistic modelling of the site in proportion to the user's field experience and geostatistical experience.

After block modelling and estimation processes performed in the field, the first images about the model is created (Figure 4).

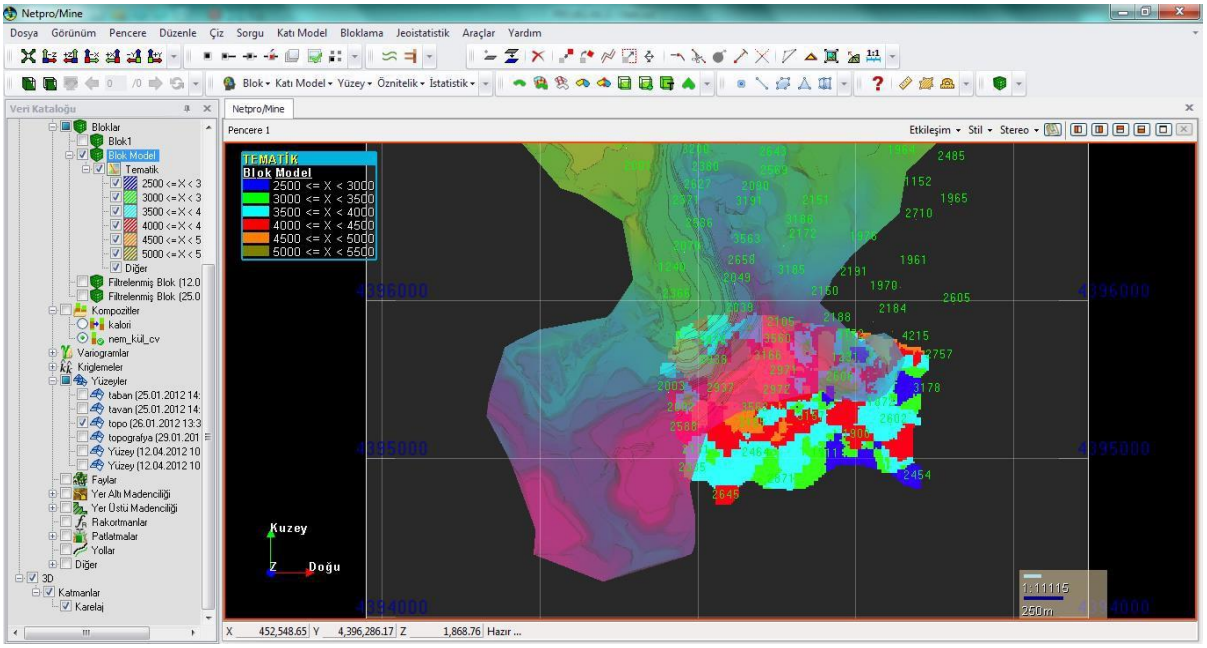

Figure 4. Demonstration of the current topographic structure of the field together with the block model

3. SURFACE MINE DESIGN

It is of utmost importance to determine bench geometries, pit haulage roads, and all connections to waste dumps and plants in open pit mine design. Although design processes require different experience and expertise than modelling, the resultant product of modelling is the input data of the design. Design criteria are determined according to the specific characteristics of each site. Open pit mine plans are designed according to the different but interrelated criteria such as deposit type, location and strength of the host rock. According to many criteria, it is aimed to perform the mine design and achieve the final view of a mine site in general (Figure 5a and 5b).

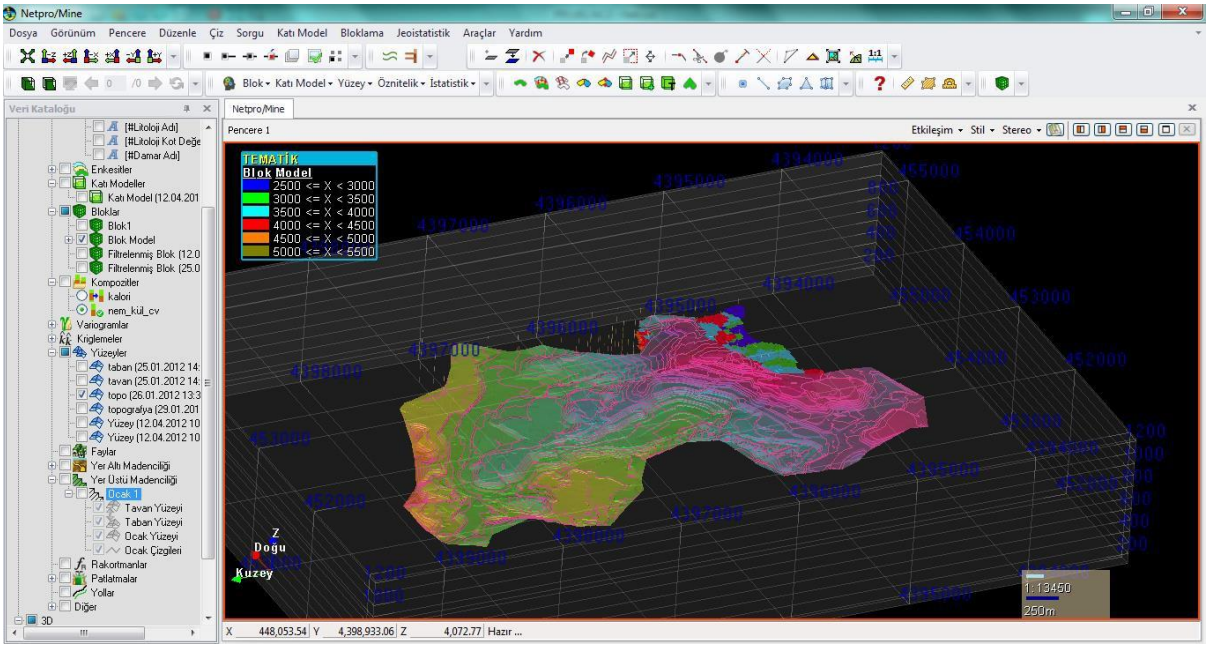

Figure 5a. Mine design and its final view

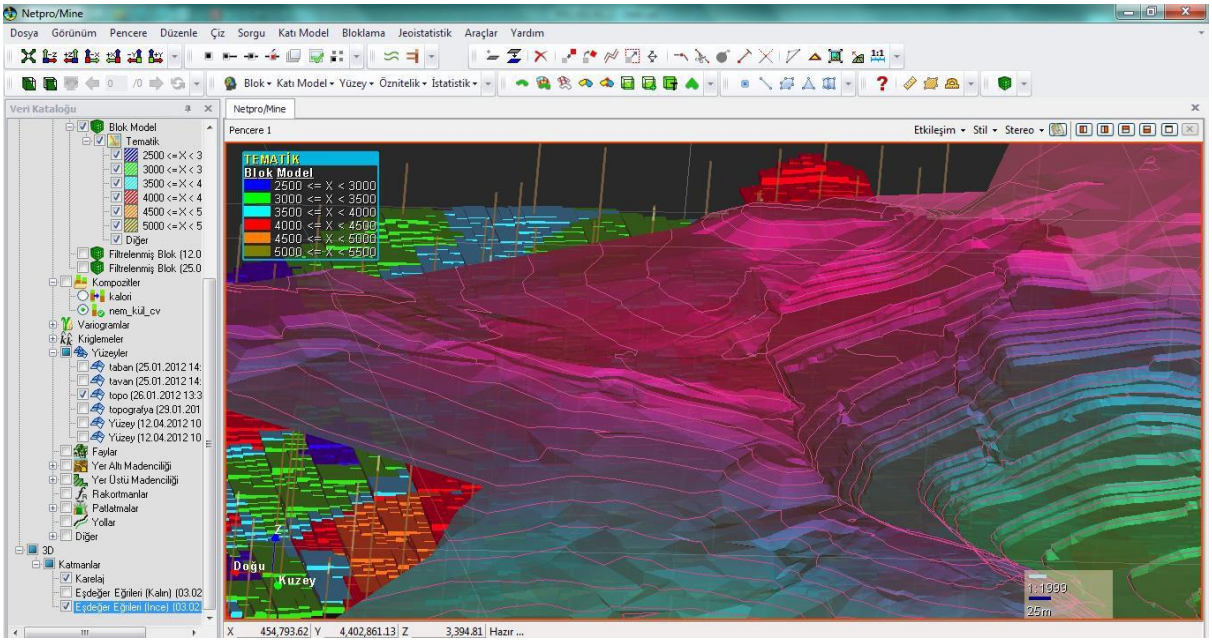

Figure 5b. Mine design and its final view

Open pits can be designed by using bottom up or top down techniques. Direction of the design is determined by whether restrictive areas are available for the mine site. If environmental

factors, areas that require permits and similar surface area restrictions are exist in the mine site, it is not possible to design the mine according to the ore deposit. In this case, design is made within the limits created after the restrictions on topography. According to the boundaries, the mine is designed from top down. The ultimate pit bottom boundary obtained in the pit designed in this way can also be updated according to the orebody base and the pit can be redesigned from the bottom up. The design has been performed by determination of the overall pit slope angle, bench slope and bench height to be used in pit design according to the pit limits (Figure 6).

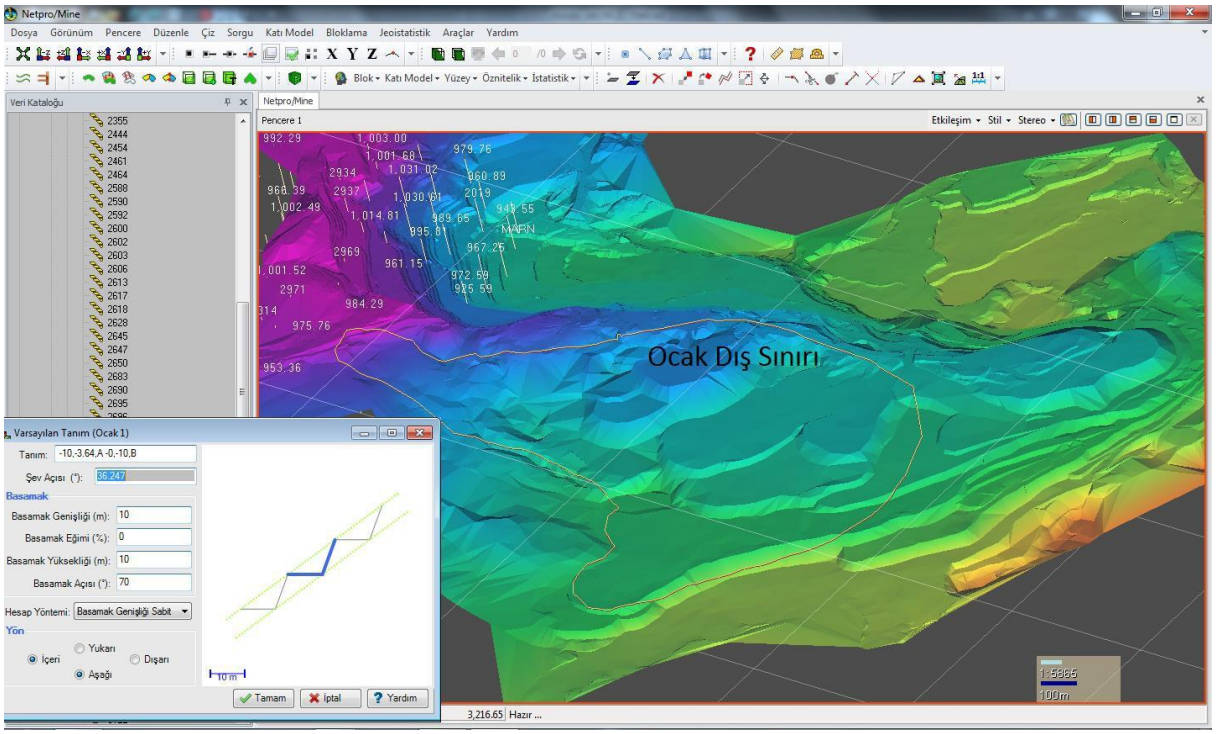

Figure 6. Determination of pit limits according to the pit design criteria

In determination of the calculation criteria, the calculation is made by taking the overall pit slope angle or bench width values. Volume of the open pit area obtained according to the pit limits determined are obtained by reporting between levels. At the same time, the visually generated open pit is combined with the existing topography to obtain the final view (Figure 7).

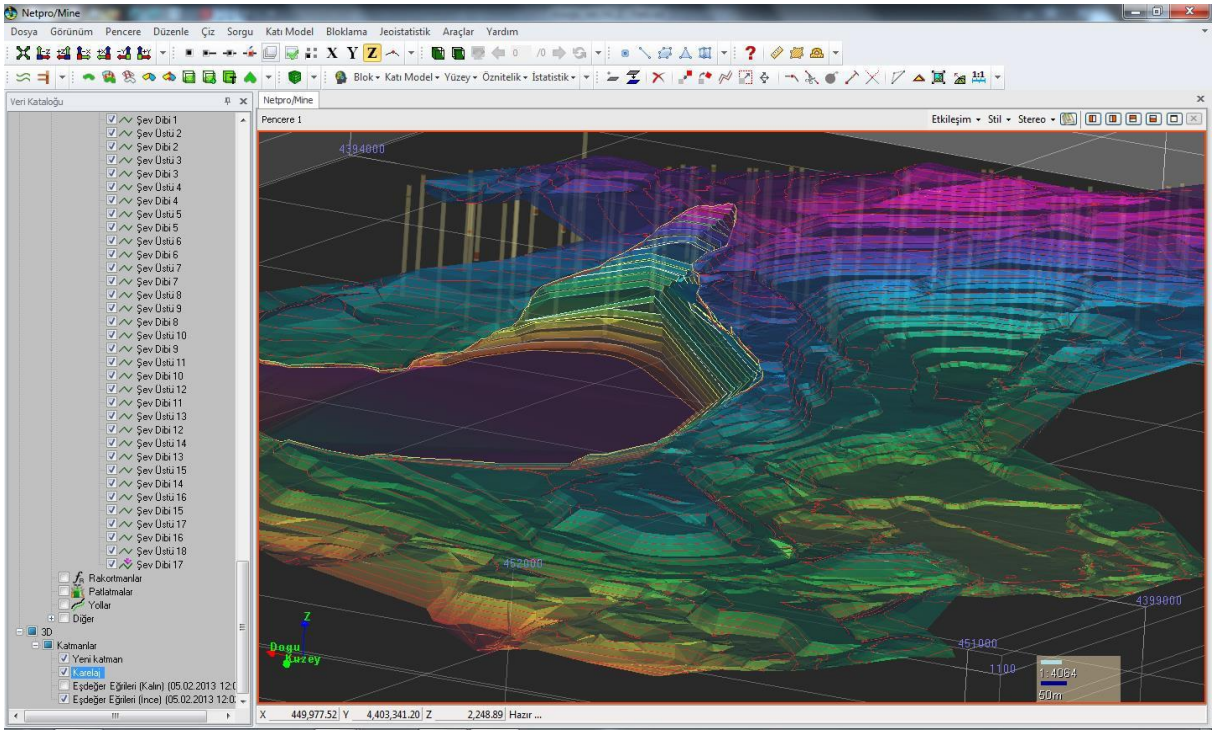

Figure 7. Final pit design

RESULTS

It is possible to perform an optimum pit design by using omputer-aided modelling and design. It is possible to get results faster than manual designs. Computer-aided software also make it easier to plan different open pit alternatives and to choose the most suitable one. Evaluating the open pits in three dimensions and taking project outputs minimizes design errors, prevents errors related to coordinates and provides speed and performance in terms of usage.

Intensive and accurate data entry by users increases the reliability of the study and provides decision support for the evaluation process.

It is aimed to increase productivity, to save time and to manage mining production data more quickly and accurately while performing open pit designs with mining software.

Designing the final open pit to produce all ore reserve can be carried out by a powerful ore body modelling and mine design software. NETPRO/Mine provides professional and user-friendly tools to assist the designer in this process.

REFERENCES

A.E. Tercan, E. Akcan (2005), "Linyit Kalitesi-Rezerv Egrilerindeki Belirsizligin Jeoistatistiksel Benzetimle Degerlendirilmesi: Ornek Bir Calisma ", Madencilik, 44, 2, 3-16

A.E. Tercan, M.A. Hindistan, B. Ünver (2012), " Resource Estimation of a Coal Deposit Using NETPRO/Mine ", 21st International Symposium on Mine Planning and Equipment Selection (MPES 2012), November, New Delhi, Hindistan, 861-870