Technical design of mining sequences to support production targets

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Abstract

Mining planning starts with calculating mining reserves, making a graphical analysis to find out the Stripping Ratio limits, and making a mining sequence design in accordance with the production target. Then, making a forecast of the need for mechanical equipment and finally create a mining scheduling by software. Based on the existing pit at the boundary of Sequence and the southern limit of the Stripping Ratio area in 2023 it is obtained that as 12 units for loading and 24-30 units for hauling. 1 unit of hauling equipment for overburden and 3 units of hauling equipments for coal. Pit design can be planned to be 4 quarterly. It can be known the estimated total coal reserves are 4,066,102 MT, Overburden 5,336,787 CCM, with a stripping ratio of 1.34 bcm/ton with an open pit area of 40.93 Ha. Design of disposal located in the northern area. Design of Pit with an average distance of 1200 Meter. The total disposal capacity based on design is 5,651,877 CCM with an area of 35.25 Ha. This condition can accommodate the entire 2023 Pit area.

Keyword

Mining planning, Production target, Technical design

Introduction

Mine design is usually intended as part of the process mine planning related to geometric problems. These include designing mining deadlines, stages and sequences mining, production scheduling, and disposal. Ultimate Pit Limit is the final or outer limit of a mine openings that are still permitted with safe slopes. Methods for designing an open pit mine boundary (Ultimate Open Pit) differentiated by the size of the deposit, quantity and quality of data, capability analysis, and assumptions from a personal employee. This limit shows the amount of minerals that can be mined and the amount of mining that must be done moved during ongoing mining operations [1].

Stripping ratio or stripping ratio is the amount of Overburden that must be moved to get the amount of coal [2]. Stripping ratio is one of the factors that really determines whether it is economical or not for extraction of coal reserves. The greater the Stripping

ratio value, this means that more Overburden has to be move to collect it coal, so the costs or costs required are also getting bigger.

Method

Resgraphic

Resgraphic is the division of blocks according to stripping ratio of each cell block to produce blocks that are feasible for mined with a certain stripping ratio [3]. This analysis is owned by the device Minescape software aims to compare existing regions. The desired coal reserves are based on the Elevation change plan mining. Prior to analysis of mining areas, blocks Mining is further divided into small blocks measuring 100 x 100 m or 50 x 50 m, so that the assessment becomes more detailed. In the Resgraphic results, blocks that have a lighter color (brown) are blocks that Limit areas that have a specified stripping ratio.

Pushback

Pushback is a form of mining (Geometric mineable) which shows how a pit will be mined, from the initial entry point down to the final shape of the Pit. other names are phases, slices, stages. The goal of this phasing is to divide the entire volume exist in the Pit into smaller planning units so that easier to apply [4].

Production scheduling

Production scheduling is a very important part of the process mining, where the target of production scheduling is determining the most optimal profit by determining production settings for a certain time period [5]. Production scheduling is carried out conventionally by trial and error, create various production scenarios and determine the most favorable scenario based on the current value of money. In other word, the faster you make a profit, the more value your money will have the better it is, the better the production scheduling will be get minerals as quickly as possible [1].

Steps cross section method

Prepare a pit design map that has been created, then make a cross-sectional path through the drill hole points. Make an incision (cross section) on the cross-sectional path of the drill hole. Calculate the area of each incision (cross section) using software image processing. Calculate the volume between 2 (two) adjacent incisions by means multiplying the average incision area by the distance between incisions (sections) use formula [6]:

$$V(A-B) = \frac{L\,(A+B)}{2}\,x\,d \qquad (1)$$

Calculation of reserves at the research location uses the cross-section method with varying distances, with an average distance of 50 meters per section, some sections have different distances because at the ends of the mining plan area the interpolation radius is 800 meters. The data analysis used for the cross-section method is using

average area data between side section, layer thickness, and distance between the two sections.

Result and Discussion

Dimension and Material Characteristic data

The density for cover soil (humus and clay) is around 1.365 tons/m3 and the coal density is an average of 1.3 tons/m3. Slope formation is influenced by rock characteristics and shape reserve, Stripping ratio. The face angle of the ladder can vary depending on rock characteristics. Generally, in massive rocks the slope angle is between 55°-80°.Meanwhile, sedimentary rocks have a slope angle of 50°- 60° with a tier height of 12–15 m. The primary data are Cycle time, Visual observation data of mining progress, and Coal slope and distribution data.

The Secondary data are Yearly production plan data, topographic data (SRTM) and Existing, Slope geometry recommendation data, Coal quality data, Availability of equipment (PA, MA, and UA), Resgraphic Pit, Mechanical equipment specifications, Rainfall data, and Working hours plan data. Based on taking strike and dip crop line seam 2 data has a strike value of N131°E with a dip value of 5 - 6°. Crop line seam point 3 has a strike value of N 93°E with a dip value of 6°. Direction of dip in all seam is relatively the same and flat, namely 5 - 6°.

Production Targets and Mining Sequence Plan

Production targets set by company is 3,600,000 tons/year for coal or 300,000 tons/month and 5,000,000 BCM/year for overburden. The target of Stripping ratio is 1:1,5. The direction of the mining sequence is planned in a down-dip manner following the direction coal strike seam. Mining begins following the direction of the Pit widening which is already running (Existing) in areas with low SR especially first. The mining pit was created based on the 2023 production target, area predetermined plan in the Pit 1 area, mining geometry calculations, Pit final design form. Then the calculation of estimated reserves is carried out per blocks (batter blocks) with a size range of 100 x 50 m. Based on estimates per block, the Pit 1 plan area can be divided into mining sequence area blocks quarterly (3 MRP). The working time is 20 hours divided into 2 shifts per day.

In this case the research uses Minescape software volume and resource calculations to estimate production targets that are close to actual conditions in the field. In reserve calculations with using Minescape 5.7 software, the overburden volume was obtained 5,336,000 BCM and 4,066,102 tons of coal. Mining plans produced in this study has an average Stripping Ratio value of 1: 1,312.

Mining Quarter 1

From January to March 2023 activities will be carried out mining in Pit 1 by opening a mining area covering an area of 13.04 Ha, to cover coal production of 716,104 tons and the Overburden 1,143,501 BCM with stripping ratio value 1: 1.6. Transport distance to out

Pit dumps for disposal units are an average distance of 1200 m and for stockroom facilities the average distance is 900 m far from the Pit 1 location. For overburden removal, 6 units of Sany SY digging and loading equipment were used 500 F and 35 units of ADT A40F transport equipment. Meanwhile, in moving coal using 7 units of digging and loading equipment and 18 units of ADT A40F transportation equipment (Figure 1).
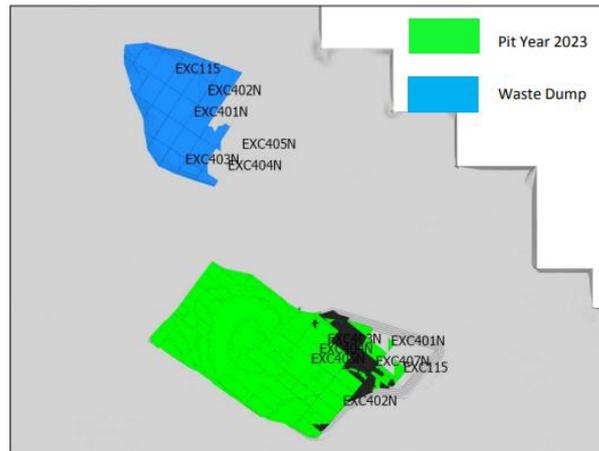

Figure 1. Quarter 1 Mining Progress Plan

Mining Quarter 2

From April to June 2023 activities will be carried out mining in Pit 1 with a mining expansion area of 9.54 Ha, to meet coal production of 889,211 tons and overburden 1,423,276 BCM with a stripping ratio value of 1: 1.6. Transport distance to disposal (Out pit dump) is an average distance of 1200 m and for the average stockroom as far as 900 m from the Pit 1 location. For overburden removal, 6 units of Sany SY digging and loading equipment were used 500 F and 30 units of ADT A40F transport equipment. Meanwhile, in moving coalusing 6 units of digging and loading equipment and 18 units of ADT A40F transportation equipment (Figure 2).

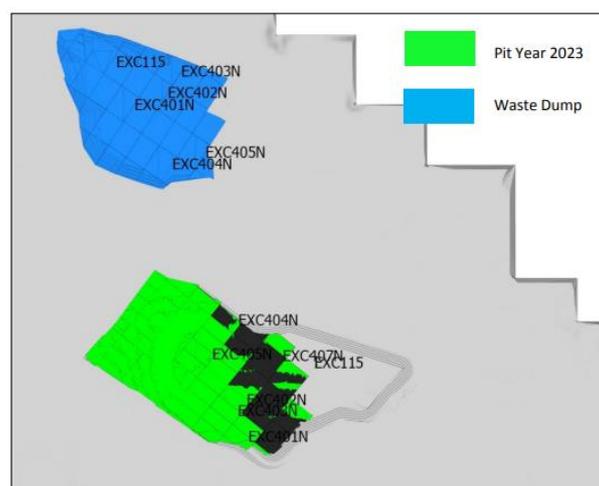Figure 2. Quarter 2 Mining Progress Plan

Mining Quarter 3

From July to September 2023 activities will be carried out mining in Pit 1 with a mining widening area to the South9.16 Ha, to meet coal production of 1,379,575 tons and

overburden is 1,587,736 BCM with a stripping ratio value of 1: 1.15. The average transport distance from the pit dump to disposal is 900 m and tostocroom an average of 1000 m from the Pit 1 location. For overburden removal, 6 units of Sany SY digging and loading equipment were used500 F and 30 units of ADT A40F transport equipment. Meanwhile, in moving coal using 6 units of digging and loading equipment and 18 units of ADT A40F transportation equipment (Figure 3).
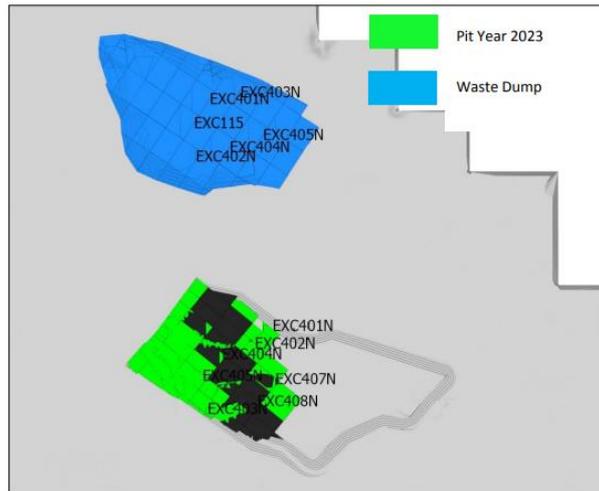

Figure 3. Quarter 3 Mining Progress Plan

Mining Quarter 4

From July to September 2023 activities will be carried out mining in Pit 1 with a mining widening area to the South 9.16 Ha, to meet coal production of 1,081,212 tons and overburden is 1,182,274 BCM with a stripping ratio value of 1: 1.09. The average transport distance from the pit dump to disposal is 900 m and to stockroom is an average of 1000 m from the Pit 1 location. When removing overburden, 6 units of Sany SY digging and loading equipment were used 500 F and 30 units of ADT A40F transport equipment. Meanwhile, in moving coal using 6 units of digging and loading equipment and 18 units of ADT A40F transportation equipment (Figure 4).
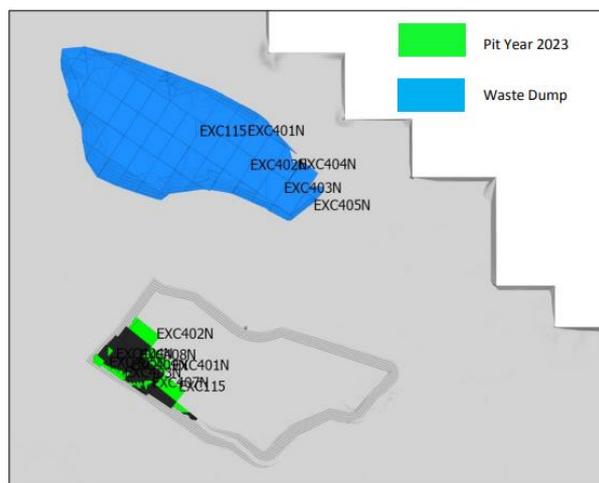

Figure 4. Quarter 4 mining progress plan

Mining slope geometry

The level geometry is based according to the recommendation from the company, namely with a level height of 5 meters, a width of 5 meters, and a single slope 35°. For actual geometry from calculating, that find of single slope 55° and overall slope 34° (Figure 5).
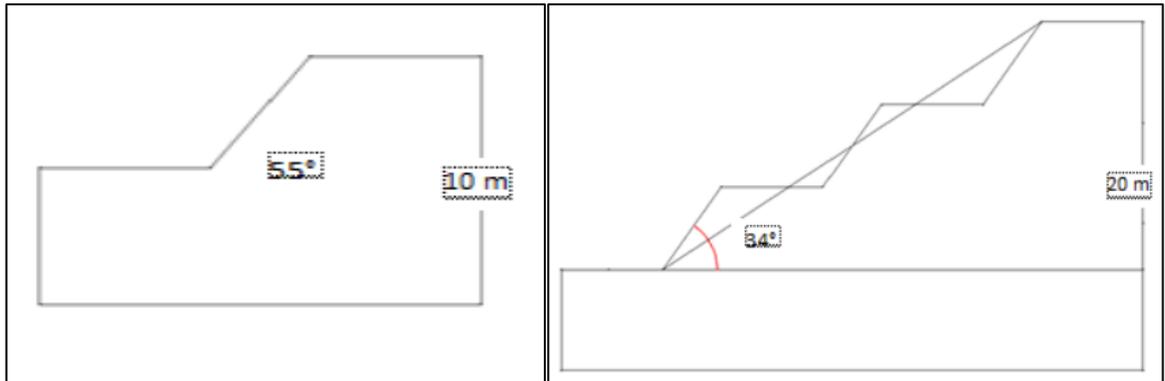

Figure 5. Single slope pit (left) and overall slope geometry (right

Disposal design

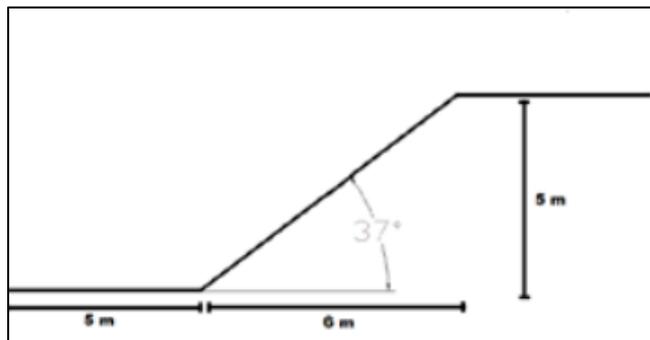Disposal plan parameters are Bench angle: 37°, Bench height: 5 m, and Bench width: 5 m (see Figure 6).

Figure 6. Disposal geometry

Volume Overburden

Tabel 1. Volume of Overburden every quarter

Volume Overburden	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Million BCM	1130656	1411267	1478095	1097159
Million BCM	1017591	1270140	1330285	987443
Losses assumed 10% CCM	1119349.87	1397153.94	1463313.81	1086187.36

The mining plan are 6 seam coal, namely S2B diving, S2C diving, S3A diving, S3BL diving, S3BU diving and S3C. S2B diving is part of diving 2 which experiences branching or (compound), the position of the coal seam in the research area is at strike N 930 E, and has a relatively gentle slope ranging from 50 – 60, then this type the appropriate mining method applied in this area is an open mining system using the open pit coal mining method. The Existing Pit area has an area of 10.65 Ha, while the area 2023 mining plan has an estimated area of 40.93 Ha. Coal seams mined in the pit yearly 2023 are in seam

orderS2B, S2C seam, S3A seam, S3BL seam, S3BU seam and S3C seam. Expansion towards the south to the limit of the production target area begins based on the lowest stripping ratio value, namely the existing low wall Pit section determined. Then the expansion is planned to continue eastward following the direction. The average strike of the coal seam is in accordance with the model that has been made.

The tool that will be used for digging and loading is the Sany SY500F series with a bucket capacity of 3.1 m3 for overburden layers and Sany SY500 with a bucket capacity of 3.1 m3 for coal. The need for digging and loading equipment in yearly 2023 is the same, namely 7 (seven) units of Sany SY500 for overburden and 7 units of Sany SY500 for coal every quarter. Tools to be used to transport overburden layers and coal is with a vessel capacity of 14 bcm. Transportation equipment needs in yearly 2023 the number is the same, namely 35 Volvo A40F units for overburden layers and 21 Volvo A40F unit for coal every quarter.

The yearly 2023 disposal area is designed to accommodate a minimum amount overburden is transferred from the design estimates that have been made. Assumed Overburden material is moved in a compacted state to the disposal area naturally or technically due to heavy equipment passing through. The disposal design is in the area north of the Pit design with an average distance of 1200 Meters. Total disposal area of 35.25 Ha so it can accommodate all of the 2023 Pit overburden. Shrinkage factor overburden material of 0.9 ccm/bcm. It is assumed that there are additions losses 10% of total overburden requirements. Disposal capacity based on sequence yearly 2023, namely 5,651,876 ccm or 106% of the 2023 pit overburden plan (Tabel 1).

Conclusion

The expansion of the Pit area is based on the existing Pit, namely to the west to the limit sequence 2023 and the southern boundary of the company's economic and economic SR area. Opening direction Mining progress is planned down-dip following the direction of the diving strike coal. Mining begins following the direction of the existing Pit expansion running (Existing) in areas with low SR first. Design Pit is planned to be 4 quarterly sequences. Estimated total reserves coal 4,066,102 MT, Overburden 5,603,398 stripping ratio value 1.34bcm/ton with an open area of 40.93 Ha. The need of loading equipment are 7 (seven) units of Sany SY500 for overburden and 7 units of Sany SY500 for coal every quarter. And for hauling are 35 Volvo A40F units for overburden layers and 21 Volvo A40F unit for coal every quarter.

Acknowledgement

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