ABSTRACT
PT. Allied Indo Coal Jaya is one of the mining companies with types of coal mining materials. Mining methods used by PT. Allied Indo Coal Jaya is an open-pit mining and underground mining method. In the underground mining method, the adding system used is a room and pillar where coal extraction activities are carried out semi-conventionally and detonation. Blasting is carried out to support coal production activities to achieve the targets set by the company. However, the problem faced today is the non-achievement of the production target in Tunnel 9, which is 33 tons of coal while the actual production is 18.70 tons of coal. The non-achievement of production targets due to the geometry of blasting is inadequate for the dismantling of coal with the desired target. Based on the calculation of the dimensions of mine progress, it was found that the coal production yield was 17.03 tons of coal, while for blasting activities using the theory of R. L. Ash, it was found that the blasting result was 12.60 tons of coal. With blasting activities that were able to dismantle 12.60 tons of coal and the number of workers as many as 6 people, a mining profit of Rp.52,435,619.27 was obtained. Increased blasting twice daily and the addition of 8 personnel in Tunnel 9 are the answers to raising coal productivity. The addition of blasting activities and the number of workers can increase coal products to 35.20 tons of coal with a mining profit of Rp. 108,407,142,864.

INDEX TERMS Blasting, Coal, Mining Advantages, Underground Mining

I. INTRODUCTION
Mining is part or all of the efforts in exploiting mineral and coal reserves on earth that have economic value. Mining activities start from the prospecting stage, general exploration, detailed exploration, feasibility studies, infrastructure development, mining, refining and processing, sales, and end with reclamation activities. Mining itself is one of the important industrial sectors of Indonesia's economic growth. PT. Allied Indo Coal Jaya is a company engaged in coal mining in Sawahlunto City. AICJ uses the Open Pit Mining method Open Pit Mining mining system which follows the slope of the coal and the Underground Mine mining system with the Room and Pillar method.

Underground mining is a mining system intended for uneconomical excavated materials in mines with an open-pit mining system, either for coal and mineral ore excavation.
materials or for excavated materials located under protected forests as stated in Government Regulation Number 24 of 2010 concerning the Use of Forest Areas and Presidential Regulation Number 28 of 2011 concerning the Use of Protected Forest Areas for Underground Mining. Coal mining using underground systems must meet 3 technical requirements, namely natural, technological, and human. Through these three requirements, it can help to determine the method of mine opening, the method of taking coal, advanced digging, coal transportation, buffering, ventilation, channeling, and others. One underground mining technique is known as "Room and Pillar," in which coal is withdrawn from a coal seam while leaving a pillar behind to fill in any blank void left behind by the removal of coal. This pillar has a predetermined size by calculating the strength of the roof, floor, and characteristics of the coal seam.

Drilling is the main operation aimed at the manufacture of cylindrical holes that will later be filled with explosives. Drilling also has a geometry that must be adjusted to the state of the rock mass to be blown up. Blasting is the activity of laying rocks from their parent rocks using explosives. In underground mines, tie-in blasting is a common job to achieve the desired production. The blasting pattern in underground mines is generally the same as the blasting pattern in open-pit mines. What distinguishes it is simply the creation of a Cut to add a field free of blasting itself.

Mechanical soil removal is any effort related to digging, loading, transporting, stockpiling, leveling, and compaction of soil or rock using mechanical tools. Mechanical soil removal in pt. Allied Indo Coal Jaya uses shovels and lorries. From the results of observations in the field, it was found that the blasting was carried out by PT. Allied Indo Coal Jaya can only dismantle 12,606 tons of coal, which production is still far from the company's expected production target of 33 tons of coal.

II. METHODOLOGY
The research process was carried out at PT. Allied Indo Coal Jaya, Sawahlunto City, West Sumatra Province. This research is applied research by combining theory and reality that occurs in the field based on primary data obtained through direct observation in the field and secondary data obtained from companies. The study was conducted by calculating the progress of the mine based on the geometry of the progress of the underground mine opening pit. Then calculated the blasting results based on the theory of R.L. Ash. Conduct analysis to achieve coal production targets and compare mining profits between actual data and processing data.

III. RESULT AND DISCUSSION
3.1 Dimensions of Mine Openings
The area of the tunnel opening hole shapes 9 PT. Allied Indo Coal Jaya has a trapezoidal shape with dimensions.

![Figure 2. Room And Pillar](image)

Drilling is the main operation aimed at the manufacture of cylindrical holes that will later be filled with explosives.

![Figure 3. Dimensions of Mine Opening](image)

Trapezoidal height (t) = 2.75 meters
Crown Width (p1) = 2.50 meters
Floor Width (p2) = 3.20 meters
Hole Progress (L) = 1.20 meters

Thus, the volume of progress of the mine is

\[ V = \left( \frac{p_1+p_2}{2} \times t \right) \times L \]

\[ V = \left( \frac{2.5+3.2}{2} \times 2.75 \text{ m} \right) \times 1.2 \text{ m} \]

\[ V = 7.83 \text{ m}^2 \times 1.2 \text{ m} \]

\[ V = 9.40 \text{ m}^3 \text{ (BCM)} \]

The condition of the coal volume that is still in place with the calculation of the formula above is obtained at 9.405 m³ (BCM). To obtain the result of the volume of coal that has been transported into the lorry, it can be known the volume by the formula:

\[ LCM = BCM : \text{Swell Factor} \]

\[ LCM = 9.40 \text{ m}^3 : 0.74 \]

\[ LCM = 12.71 \text{ m}^3 \text{ (Data Processing Production)} \]

Tonnage = 12.71 m³ x 1.34 tons/m³
Tonnage = 17.03 tons of coal

3.2 Blasting Results
Based on the actual blasting geometry, namely:

- Burden = 0.7 m
- Space = 0.7 m
- Depth = 1.20 m
And with the number of explosive holes used as many as 16, the results of rock tonnage were obtained that were uncovered in one blast using the R.L. Ash formula, namely:

\[ V = B \times S \times L \times n \]

\[ V = 0.70 \times 0.70 \times 0.70 \times 16 \]

\[ V = 9.40 \text{ m}^3 \]

\[ t = 9.40 \text{ m}^3 \times 1.34 \text{ tons/m}^3 \]

\[ t = 12.60 \text{ tons} \]

### 3.3 Blasting Costs

Table explosives price

<table>
<thead>
<tr>
<th>No</th>
<th>Explosives</th>
<th>Sum</th>
<th>Unit</th>
<th>Price (Rp)</th>
<th>Total (Rp)</th>
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<tr>
<td>1</td>
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<td>Pcs</td>
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<td>Kg</td>
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<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>550.153</strong></td>
<td></td>
</tr>
</tbody>
</table>

From the calculation of the price of explosives, a total cost of IDR 550,153.00 was obtained for one detonation with the total production obtained as much as 12.60 tons of coal. For every ton of coal-generated in a day by the workers in tunnel 9, a wholesale system is used. The cost of one ton of coal is Rp80,000.00, so:

Worker's Salary = amount of production per day x wholesale wages

Worker's Salary = 17.03 tons x Rp.80,000.00
Worker Salary = Rp 1,362,400.00
Total Cost = Rp. 550,153.00 + Rp. 1,362,400.00
Total Cost = Rp 1,912,553,00

### 3.4 Production Deficiencies

The actual data obtained in the field is the daily coal production of 17 tons of coal, and 12 of them are dismantled using the blasting method. Meanwhile, the company's coal production target is 33 tons/day. So the shortage of coal production in tunnel 9 is:

33 tons – 17 tons = 15.97 tons of coal

### 3.5 Addition of Blasting

The addition of Blasting Activities to the main pit can increase coal production. So that in a day coal production can be increased to:

- Amount of coal in one blast x 2
- 12.60 tons x 2
- 25.21 tons of coal

### 3.6 Addition of Workers

As a result of the actual data in the field, 17 tons of production per day were obtained with a total of 6 workers. With the addition of blasting, the total production in a day can be increased to 29.606 tons of coal, so that the remaining coal that must be excavated becomes 3.40 tons of coal.

\[ \text{Production Yield} = 17 \text{ tons} + 12,606 \text{ tons} + 5.6 \text{ tons} \]

\[ \text{Production Yield} = 35,206 \text{ tons of coal per day} \]

### 3.7 Production Costs

The addition of blasting activities will increase the cost of blasting due to the addition of the use of explosives, bringing the total cost for blasting to:

Total Blasting Cost = Rp 550,153.00 x 2
Total Blasting Cost = Rp 1,111,306.00

The increase in coal production will also increase the wages of tunnel 9 workers, so:

Workers' Wages = 35,206 tons of coal x Rp 80,000.00
Worker's Wages = Rp 2,816,480.00

So the total cost of production of tunnel 9 after the addition of blasting and worker activities became:

Total cost = Rp 1,110,306.00 + Rp 2,816,480.00
Total Cost = Rp. 3,926,786,00

### 3.8 Coal Price

In February 2022, coal prices were determined using data on coal quality, and one ton of coal cost 216.53 dollars. Since the rupiah is worth IDR 14,369 to the US dollar, the cost of one ton of coal can be calculated as follows:

Coal Price = 216.53 $/ton x Rp. 14.369
Coal Price = Rp 3,111,319.57

### 3.9 Mining Advantages

The profit of mining activities is obtained by multiplying coal production by the price of coal and reducing it by the cost of production, or can be seen in the formula below:

Mining Profit = (Production x Coal Price) – Cost of Coal

#### 3.9.1 Prior to the addition of blasting and Worker activities

Mining Profit = (Production x Coal Price) – Cost

Mining Profit = (17.03 x Rp 3,111,319.57) - Rp550,153.00
Mining Profit = IDR 52,985,772.27 – IDR 550,153.00
Mining Profit = Rp 52,435,619.27

#### 3.9.2 After the Addition of Blasting and Worker Activities

Mining Profit = (Production x Coal Price) – Cost

Mining Profit = (35.20 x IDR 3,111,319.57) - IDR 1,111,306.00
Mining Profit = Rp 109,518,448.86 – Rp1,111,306,00
Mining Profit = Rp 108,407,142.86
IV. CONCLUSION

Based on the calculation of the dimensions of mine progress, it was found that the coal production yield was 17.03 tons of coal, while for blasting activities using the theory of R. L. Ash, it was found that the blasting result was 12.60 tons of coal. With blasting activities that were able to dismantle 12.60 tons of coal and the number of workers as many as 6 people, a mining profit of Rp.52,435,619.27 was obtained. Increasing blasting twice a day and adding 8 personnel to Tunnel 9 will boost coal productivity. The addition of blasting activities and the number of workers can increase coal products to 35.20 tons of coal with a mining profit of Rp. 108,407,142,864.

REFERENCES


