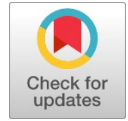


# Overview of Line Excavator (Dragline) Role in Optimization of Production in Surface Mines

A L Ravikumar Lakkana, Somesh Bhambi



**Abstract:** In coal mining, draglines have long been used, either alone or in conjunction with coal extractors as strippers. Because this type of technology has intrinsic benefits over its competitors, it must operate seven days a week, 24 hours a day, to increase production and save costs. In the nation of India, the expansion of significant surface mining operations such as Bina and Jayant, as well as the setting of high coal output goals (up to 10 MT/year), requires the development of technologies that can remove huge amounts of overburden in the shortest amount of time. As a result, the technology for removing overburden and interburden in surface coal mining has shifted from shovels to draglines. Coal India Limited (CIL) established a standard dragline in two different sizes: 10/70 and 24/96. Most mines employ draglines throughout the clock, every day of the week. The dragline is the major stripping equipment in many coal mines, and its performance has a direct impact on mine production. To minimise the effect on the mining operation, dragline designs focus on creating components with higher levels of predictability and reliability for planned component replacements and repairs. To determine the appropriate size, several factors must be considered when installing draglines in mines. Dragline's productivity and output are measured using various indicators. This thesis has covered these subjects in detail. The need for energy continues to grow. Coal, the most evenly distributed raw material in the earth's crust, is one of the most important fossil fuels. Surface mines are used to extract a large amount of coal. Large machinery is used, and most processes are automated, particularly in the context of economies of scale extraction. Draglines have long been employed in coal mining, either as strippers or as a combination stripper and coal extractor. The following technology must be utilised around the clock to ensure high output and low costs, as it possesses intrinsic advantages over its competitors. Despite its enormous size, draglines have a straightforward work schedule that consists of walking and excavation. One of these is walking, a dependable technique over which the mine design team has some influence. The stride length of almost all walking draglines is around 1.8 meters in 0.75 to 1 minute. The main factors affecting the frequency and length of prolonged deadheading periods, throughout which the unit is ineffective, are management's coal loading strategy and strip panel design, which offers an easily understood section with one operator's room on the predicted side or two on both sides (Erdem et al., 2003).

**Keyword:** Coal Extractors, Surface Mining, Mining Operation, Economies

**Abbreviations:**

CIL: Coal India Limited

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## I. INTRODUCTION

For several decades, the dragline has been used extensively to economically harvest minerals at ever-deeper depths [1]. There are now large draglines with enormous bucket capacities and more extended booms, which are traits associated with higher productivity [2]. In addition to the high degree of flexibility, employing a dragline has a very low cost per cubic meter, which in turn leads to a very low cost per tonne of the required mineral. A dragline requires a significant initial investment; hence, achieving lower overburden stripping costs requires competent and efficient operation. Continuous monitoring, proper overburden preparation, preventative maintenance, and selecting the optimal bench height for the overburden are all essential to ensure the dragline's successful and efficient operation [3]. The entire mining operation may be significantly impacted by increased dragline productivity. It is believed that appropriate application evaluations, continuous engineering, and manufacturing can be accomplished due to several field instances. A dragline can improve the efficiency of deep strip mining under certain circumstances [4]. The extensive use of leas in the mining industry nowadays is, to put it mildly, more crucial than ever.

### A. Aim

The project's goals are to assess dragline mining in India, identify flaws and improper methods, and provide recommendations for improvement.

A combination of field research and data gathered from various sources is then used to compute the estimated outputs, ownership and operating costs, and the cost per ton of coal exposed by the dragline. Creating a computer program (in C++) to design bench draglines (while maintaining a constant cut width) and assess whether rehandling is necessary, as well as estimating yearly overburden production and computing ownership, operating costs, and dragline cost per cubic meter of overburden handled, is another goal.

## II. OBJECTIVES OF THE STUDY

1. Make a C++ software and a dragline balancing diagram to build a dragline bench with a constant cut-width. Assess if rehandling is necessary.
2. Develop a C++ software to predict yearly overburden production, calculate ownership, operating costs, and cost per cubic meter handled by the dragline.

## III. METHODOLOGY USED

To achieve the given aims, the following strategies were used:

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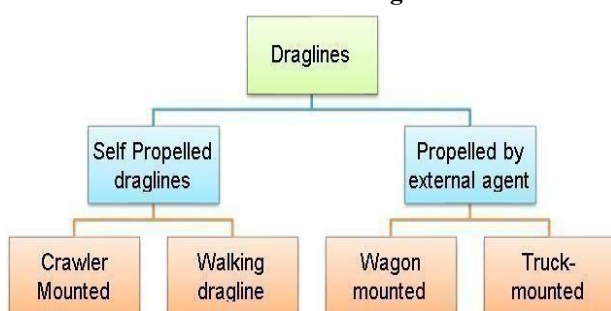
- A. A critical analysis of recent research. Inspections of dragline mines are conducted to collect and document various research parameters.
- B. To get the necessary results, methodical calculations and computer programming are required. Rapid industrialization and population expansion have increased the need for coal as a source of energy and a fuel, which has led to the need for opencast coal mines to improve their automation of coal extraction and O/B removal. Deeper opencast mines with greater stripping ratios are planned to meet increased demand. These deep and vast opencast mines have resulted in some good improvements in mechanization. It has prepared the way for the deployment of massive, heavy earth-moving devices.

To achieve the desired outcome, opencast coal mines now require a substantial amount of heavy earth-moving equipment. The O/B removal method should be both efficient and cost-effective. Geo-mining circumstances, such as the thickness of the O/B layer, often determine the equipment used for:

- Thickness of O/B removal.
- Thickness of coal seam.
- Seam gradient.
- Pit geometry.
- Strike duration.
- O/B elimination grade.
- Mine life
- Geological disturbances
- Capital available.

In a relatively long and narrow open pit that is a component of a network of adjacent and parallel pits, draglines are frequently used to mine, convey, and unload O/B material. Draglines have gained in popularity due to their extended reach and the scarcity of supporting hauling equipment. It simultaneously removes and reclaims the O/B. This paper examines various aspects of dragline operation through a case study from an Indian opencast coal mine.

### Classification of Draglines



### A. Cycle time Analysis:

Tables and graphs are created and shown using the data collected during field research. For equal swing angles, there is minimal difference between swinging to and swinging back. The two-time portions vary along with the swing angle. Dumping time is relatively constant. Scooping time varies with the cycle. The degree of fragmentation of the O/B material being treated has a significant impact on cycle time. As a result, appropriate blasting techniques must be

employed. However, because this variable remained constant throughout the trial, the current experiment was unable to evaluate the impact of the degree of fragmentation on scooping time.

The production index and rate of O/B m<sup>3</sup> per working hour per m<sup>3</sup> bucket capacity are inadequate. The rate of re-handling is also high. The efficiency factor, which is computed by multiplying availability and utilization, is rather low. Numerous professionals believe that implementing four shifts with overlap is a good compromise for increasing dragline reliability and usage. During these downtimes, ideal hours should be reduced.

### B. Ideal Time Analysis:

The graphs of bars for the 15/90 and 24/96 draglines reveal five significant machine causes of idling: a lack of power, dozing, blasting, idle walking, and others.

The lack of power supply accounts for 24.87% of the total period of inactivity on the 15/90 dragline. In the case of a 24-96 dragline, 26/5% of the sleeping operations result in a loss of 21/98% and 23.83% of the total idle hours. Blasting is the third major operation. In the case of the 15/90 dragline, it accounted for 20.94% of total idle time.

Blasting actions made up 16.11% of the 24/96 dragline, ranking fourth. Miscellaneous US activities, such as officer inspections, operator absences, losses during tiffin hours, and shift changes, amounted for 21.76% of total idle hours on the 24/96 dragline and 18.58% on the 15/90 dragline.

## IV. DATA COLLECTION, RECORDING AND ACQUIRING

In a relatively long and narrow open pit that is part of a network of adjacent and parallel pits, draglines are frequently used for mining, transporting, and unloading overburden (O/B) material. On-site measurements were taken for the duration of the loading cycle, capacity of the bucket, length of the boom and height of the dump. Rai (2004) collected comparable information from earlier field research at the Singareni OC-I mine. In contrast, the Samaleswari (MCL) mine's planned working hours, average working hours, idle hours, average interruption hours, and standard and general hours were derived from previously recorded data.

Previous studies in this location have demonstrated a significant reduction in accessible hours for these HEMM due to blasting activities, sleeping operations, tiffin times, shift changes, and other factors.

Therefore, after reviewing the key reasons for machine idleness, responsibility must be dispersed among the administrative group. For example, losses due to prolonged tiffin times, shift changes, and so on might be attributed to the "executive group. The mining group may be held accountable for losses resulting from blasting operations, machine walking, and dozing. In contrast, the technical group may be held accountable for losses resulting from a lack of auxiliary equipment or services. By encouraging healthy competition, this clear separation of responsibilities for machine idle time may significantly lower idling losses.



V. PROGRAMMING AND CALCULATION

A. Balancing Diagram of a Dragline

The balancing diagram of dragline, as its name suggests, shows how to set up the dragline to expose coal at high rates and stabilize the slope by handling the most significant overburden in the decoaled zone with the least amount of rehandling.

Maintaining balanced graphs helps determine how much coal a dragline can extract, how much overburden needs to be rehandled, and how much overburden is required to fit into a decoaled zone.

It also shows bench height, dragline cutting width, cross-section, and dragline cut width (in two dimensions). The figure's cross-sections can be used to forecast the order of cuts made by the dragline, key cut (box cut), and first dig.

B. Aims of the Balance Diagram

- i) Dragline cut parts, which include the initial dig (adjacent to the dig) and the rehandled section (depending on the type of operation).
- ii) Among other things, it shows the gradient, different slope angles, coal seam thickness, dragline bench height, and dragline cut width.
- iii) Coal exposure rates are calculated on a daily, monthly, and annual basis.
- iv) Their annual output determines the workload distribution of draglines; that is, the area of the cross-section that each dragline occupies should be commensurate with its production.
- v) Determine the rehandling percentage. It is calculated how much overburden the de-coaled area can support.

C. The Dragline-Balancing Diagram's Design

Assume that the cross-sectional zone that will be removed to reveal coal seams A, B, C, and O is BCDE.

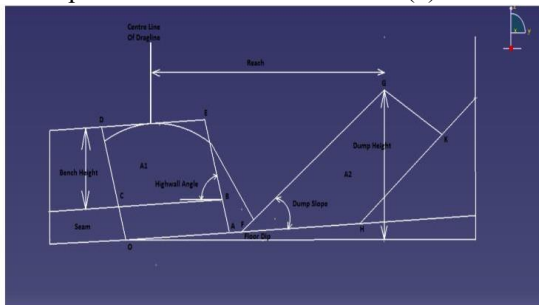
Let A1 be the first dig -----(1)

After that, the highwall side on the dragline uses a hydraulic hammer to remove the blasted O/B from the first-dig's cross-sectional area. The dump can accommodate a huge amount of O/B. FGKH is constrained due to the dragline's reach and the slope of the dump.

Let A2 be the Dumping Area -----(2)

Assuming S is the material's swell factor, the actual amount of stored overburden in the dump is A1S.

Let A3 represent A1S - A2. ----- (3)



[Fig.1: Dragline Balancing Chart for Total Side Casting]

Case-1 When A3 < 0

In the present instance, more O/B can be poured than was excavated the first time around. If the dragline bench height or cut breadth is increased, so will the number of first digs. If

necessary, repeat the process until the dump area equals the amount lost in the original excavation.

Case-2 When A3 = 0

As a result, the simple dragline installation technique of side-casting provides an excellent option. A basic side casting process involves no material handling, making it the most cost-effective procedure. If the dragline bench height or cut breadth grows, there is no method to handle the increased first-dig.

Case-3. When A3>0

As a result, a third of the burden would be left behind. You can either transfer and dump it somewhere or expand the dump capacity by extending the reach. Use longer-reaching devices to extend your reach. However, the alternatives are limited. You may also extend the reach by repositioning the dragline away from and toward the dump. Dragline installation is carried out using the extended bench approach.

Developed C++ Software to Build Dragline Benches with a Consistent cut Width and determine if re-handling is Necessary.

```
#include <stdio.h>
#include <stdlib.h>
// Define a struct for excavation parameters
typedef struct {
    float length;
    float breadth;
    float height;
    float dump Area;
    float swell Factor;
    float area1;
    float area3;
} Excavation Params;
// Function to calculate the first dig area
float calculate First Dig Area (Excavation Params params) {
    float area = ((params. length + params. breadth) / 2) *
    params. height;
    return area;
}
// Function to calculate excess area
float calculate Excess Area (float area1, float dump Area,
float length) {
    float excess Area = (area1 * length) - dump Area;
    return excess Area;
}
// Function to determine height and rehandling requirements
void determine Height and Rehandling (float excess Area,
float dump Area, float swell Factor, float* height) {
    if (excess Area < 0) {
        printf("The height earlier was %.3f\n", *height);
        *height = (2 * dump Area) / (swell Factor * (length +
breadth));
        Printf ("The height is now %.3f\nNo rehandling
required\n", *height);
    } else if (excessArea == 0) {
        Printf ("The height is now %.3f\nNo rehandling
required\n", *height);
    } else {
        Printf ("The height is now
%.3f and the extra area is
%.3f\nThe reach has to be
```



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```

increased\n", *height, excess Area);
}
}
int main () {
    Excavation Params params;
    // Input parameters
    Printf ("Enter length, breadth, and height: ");
    Scanf ("%f %f %f", &params. length, &params. breadth,
& params. height);
    params. area1 = calculate First Dig Area (params);
    printf ("First dig area is now %.3f\n", params. area1);
    printf ("Enter dump area and swell factor: ");
    scanf ("%f %f", &params. Dump Area, & params. Swell
Factor);
    params. area3 = calculate Excess Area (params. area1,
params. Dump Area, params. length);
    determine Height and Rehandling (params. area3, params.
Dump Area, params. Swell Factor, & params. height);
    system("pause");
    return 0;
}

```

### Output Case 1 (A3<0) (using User-Defined Data)

Entered Input:  
top cut width (length): 80m  
width of the cut at the bottom (length):50m  
Height of a bench:28m  
Area for dumping: 2400 m2  
Factor of swelling: 1.25  
Output:  
Earlier, it was 28 meters high.  
The latest elevation is 29.538 meters.  
The extra space is 0.  
There is no need for rehandling.

### 4.4.4 case 2 (A3=0)

Entered input from case 2:  
top cut width (length): 80m.  
width of the bottom cut (breadth): 50m.  
Height of a bench:28m  
Area for dumping:2275m2  
Factor of swelling:1.25

### Output:

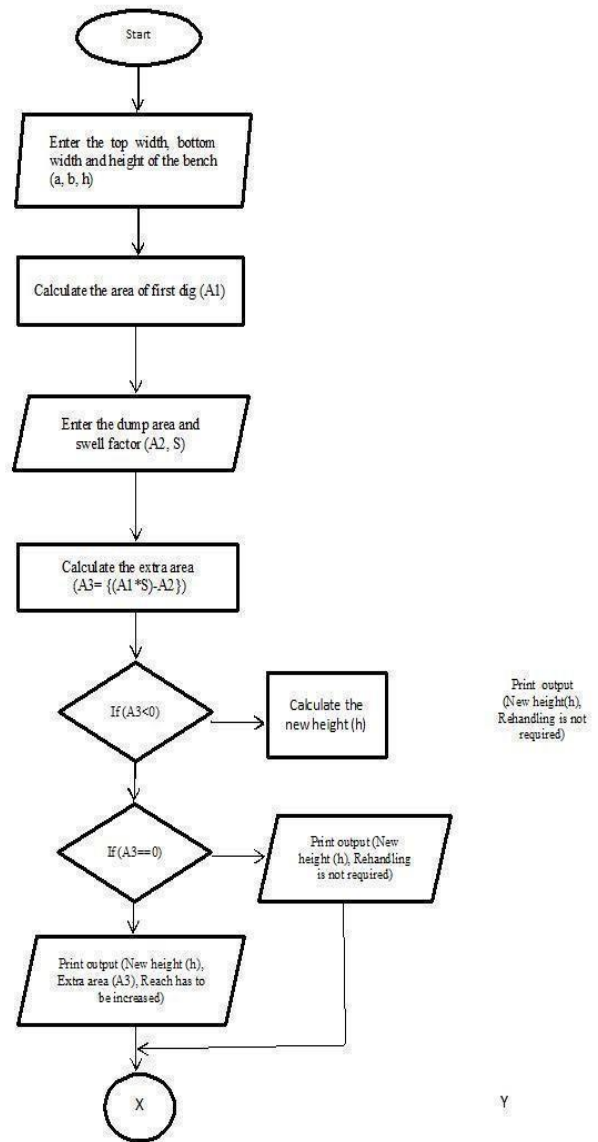
The elevation gain is 28 meters.  
There is no need for rehandling.

### 4.4.3 case3 (A3>0)

Input entered from case 3:  
uppermost cut width (length):80m  
Cut width at the bottom (breadth):50m  
Height of the bench:28m  
Area of the dump:2000m2  
Factor of swelling 1.25

### Output:

It is presently 28 meters high.  
The extra space is 275 m2.  
Reach has to be increased.



[Fig.2: Workflow to Determine if Rehandling is Required when Building the Dragline Bench (While Maintaining a Consistent Cut Width)]

Annual production, ownership, and operating costs are computed, together with the price per tonne of coal exposed by dragline.

### Assessment of Availability and Utilization

By entering field data into Equations I and II, we were able to calculate availability and utilization (ii).

$$A = \frac{SSH-(MH+BH)}{SSH} \dots\dots\dots (i)$$

$$U = \frac{SSH-(MH+BH+IH)}{SSH} \dots\dots\dots (ii)$$

Were,  
Scheduled Shift Hours or SSH,  
Maintenance Hours or MH,  
Breakdown Hours or BH,  
Idle Hours or IH,

$$P1 = (B/C) \times A \times S \times F \times M \times N_s \times N_h \times N_d \times 3600 \dots \dots \dots (iii)$$

Where,

B, the cubic meter capacity of the dragline bucket,  
C, the average total cycle time in seconds for the dragline  
S stands for the factor of swelling,  
F stands for filling factor.

M, the travel, and placement factor of the machine,  
N<sub>s</sub>, the total quantity of opening shifts that occur in a day,  
In a change, the total number of opening shifts  
N<sub>d</sub>, the total number of yearly opening days.

Equation 1 was used to forecast P1 based on the average cycle duration, A, and U values of the dragline (iii).

Based on field data, this equation has been amended to incorporate values for average cycle duration (C), average cycle area (A), and average cycle volume (U)—the values of S, F, and M in Eq. III. iii remained constant because of the CMPDI's recommendations for these components' values in Indian coal mines. Table 4.1 displays the suggested values for each of these variables.

**The formula gives the most incredible depth that a dragline can operate:**

$$H = \frac{t + \tan x (R - W/4)}{S + (\tan x / \tan y)} \dots \dots \dots (iv)$$

For the OC-I Dragline (24/96)

The dragline can work at its maximum depth (H).  
The thickness of the seam of coal (t) is 4.55 meters.  
The overburden's angle of repose is 38.5°

Dragline reach (R) = 73 meters.

Factor of swelling (S) = 1.38

Cutting Width (W) = 60m

Slope angle between the high wall and horizontal (y) = 70

Equation (iv) using the data values mentioned above

$$H = \frac{\tan 38.5 (73 - 60/4) + 4.55}{1.39 + (\tan 38.5 / \tan 70)}$$

Following the computation, we obtain H=29.78m

Thus, the greatest depth that may be worked is 29.74 meters.

Regarding the dragline in Samaleswari (10/70):

Maximum depth that draglines can work (H)

Coal seam thickness (t) =25m

Reposed angle of overburden (x) =38.5

Dragline reach (R) =58.77

Swelling factor (S) =1.39m

Cutting width (W) =50m

Angle of slope from highwall to horizontal (y) = 70

**Rehandling Amount (PRM) (Singareni OC-I uses the extended bench method)**

$$PRM = \frac{(1.125t + 0.684H + 0.1R)}{W} +$$

$$\frac{(0.25t^2 - 0.4Rt - 0.16R^2)}{V} +$$

$$\frac{(0.1t + 0.08R - 0.01W)}{H} \dots \dots (V)$$

Dumping height of overburden (H) =42m

Coal seam Thickness (t) =4.51m

Dragline reach (R) =72m

Cutting width (W) =60m

$$PRM = \frac{(1.125 \times 4.51) + (0.684 \times 42) + (0.1 \times 72)}{60}$$

$$+ \frac{(0.25 \times 4.51^2) - (0.4 \times 72 \times 4.51) - (0.16 \times 72^2)}{40 \times 60}$$

$$+ \frac{(0.1 \times 4.51) + (0.08 \times 72) - (0.01 \times 60)}{40}$$

$$= 0.662 - 0.40 = 0.14$$

$$= 0.402$$

So, the percentage of rehandling amount = 40.2

**Projected yearly production of the dragline**

$$A = \frac{720 - (119 + 33)}{720} = 0.7888$$

$$U = \frac{720 - (119 + 33 + 61)}{720}$$

Thus, we are given availability = 0.7899

Utilizing factor = 0.7042

Regarding the dragline utilized in Samaleswari (10/70)

The information utilized in Equations (i) and (ii) from Table 2

$$A = \frac{720 - (91 + 31)}{720}$$

$$= 0.8332$$

$$U = \frac{720 - (91 + 31 + 60)}{720}$$

$$= 0.75$$

So, the availability we get = 0.8333

Utilization factor = 0.75

Utilization factor cum availability (k) = AxU = 0.625

Using the information gathered, acquired, and suggested in Eq. (iii)

For the OC-I Singareni dragline

$$P1 = (24/61.7) \times 0.555 \times 0.733 \times 0.8 \times 8 \times 3 \times 365 \times 60 \times 60 = 2.817 \text{ M Cu.m}$$

The dragline's expected annual production at Singareni OCP-I is therefore 2.807 million cubic meters of copper.

Regarding the utilization of the dragline in Samaleswari

$$P1 = (10/66.3) \times 0.625 \times 0.719 \times 0.733 \times 0.8 \times 8 \times 3 \times 365 \times 60 \times 60 = 1.253 \text{ M Cu. m}$$

Therefore, 1.253 M Cu. m is the anticipated yearly production of the dragline at Samaleswari.

**Estimation of dragline ownership and operation costs for Singareni OC-I**

The 24/96 dragline's yearly cost of ownership

- (i) Equipment cost = Rs. 1001 million
- (ii) The cost of depreciation over 25 years, or a flat 4% annual rate  
Depreciation expenses for 24/96 draglines each year = Rs. 40.4 million.
- (iii) Ownership Cost Per Year (24/96)
- (iv) Average annual investment  
=  $\frac{N+1}{2N}$  \* dragline cost

where N = dragline life + 1000 \* 26 = 521 million rupees

(iv) Taxes, insurance rates, and annual investment. that is, a 12.5% annual flat rate, or 15% of Rs. 520 million

Thus, the annual total cost of ownership = (ii)+(iv)

$$= (41 + 78) \text{ million rupees}$$

$$= 119 \text{ million rupees}$$

**Operating expenses for the 24/96 dragline per year**

- (i) The annual cost of labour (including salaries and pay)

For two operators working three shifts, the operating cost is



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Rs. 0.20 million per operator, or Rs. 1.21 million.

For one operator working three shifts, the cost of an assistant is Rs. 0.14 million, or 0.425 million rupees.

The total cost of manpower is 1.672 million rupees.

- (ii) The 24/96 energy consumption and power consumption were 13.65 M kWh.

The cost of using power annually is 4.89 rupees/KWH

= 4.89 rupees x 13.615 x 10<sup>6</sup>.

= 66.75 million rupees

- (iii) 30% of yearly power usage is spent on lubrication, which comes to Rs. 20.035 million.

- (iv) The cost of annual maintenance is Rs. 8 million, or 20% of the cost of depreciation.

The cost of severe breakdowns is Rs. 20 million, or 2% of the equipment cost.

The total cost of upkeep is 28 million rupees.

Therefore, the total annual running cost equals the sum of the following: labour cost, electrical cost, maintenance cost, and lubrication cost.

= (1.621 + 66.715 + 20.015 + 28.5) million rupees.

= 117.4 million rupees.

Total operating and ownership costs

= yearly operational expenses plus yearly ownership expenses

= (117.4 + 118) million rupees.

= 235.4 million rupees.

Based on an annual production of 24/96, the dragline operating cost per m<sup>3</sup> overburden handling is computed as follows: 2.817 M Cu. m =  $\frac{234.4 \times 10^6}{2.817 \times 10^6}$

$$\frac{2.817 \times 10^6}{2.817 \times 10^6} = 81.67 \text{ rupees}$$

### Extended bench technique for Singareni OCP-I Dragline cost exposed per tonne of coal

With a yearly production capacity of 2.817 million cubic meters, the dragline currently in use is the 24/96 model. A total of 40.2% gets rehandled.

Overall handled overburden = overburden over the exposed coal directly + rehandled overburden = overburden over the exposed coal (1 + coefficient of rehandling).

In this case, the coefficient of rehandling is the ratio of O.B. rehandling divided by O.B. removal to expose coal.

Thus, 2.87 M Cu. m = overburden just above the coal that is accessible x 1.40

Therefore,  $\frac{2.817 \text{ M Cu. m}}{1.40}$  is the overburden directly

Above the coal that was mined and removed by a dragline. = 2.05 M Cu. m

Coal exposure =  $\frac{2.05 \text{ M Cu. m}}{4.2 \text{ m}^3/\text{te}}$

= 0.82 M te

An estimate of the cost per tonne of exposed coal

= Rs.  $\frac{234.34 \times 10^6}{0.82 \times 10^6}$

= Rs. 286.78

= Rs. 286.78 / ton of exposed coal

### Formulas for Calculating the Ownership and Running Costs of a Dragline (Samaleswari Dragline)

Annual ownership costs for the 10/70 dragline

- (i) Equipment cost 24/96 dragline Cost

- (ii) Depreciation costs for 25 years at a fixed rate of 4% per year. The annual depreciation cost of a dragline is 10/70 = Rs. 12 million. Ownership cost per year (10/70): Yearly average investment =  $\frac{N+1}{2N} \times \text{dragline cost}$ .

$\frac{2N}{2N}$

- (iii) The tax rate, insurance rate, and yearly interest rate, which are all fixed at 12.5%

= 15% of Rs. 157 million

= Rs. 23.41 million

Therefore, (ii) + (iv) is the total yearly cost of ownership.

= Rs. (12 + 23.4) million

= Rs. 35.5 million

### Using the straightforward side-casting process, the Samaleswari dragline estimates the costs per tonne of coal extracted.

The dragline that was erected on 10/70 has a 1.253 M Cu. m/year production output.

1,253 M Cu. m is the volume of managed overburden.

Volume of exposed coal =  $\frac{\text{production of a dragline yearly}}{\text{Average ratio of stripping}}$

Average ratio of stripping

=  $\frac{1.253 \text{ M Cu. m}}{3 \text{ cu, m/te}}$

= 0.417 M te

Calculating the price per tonne of exposed coal = Rs.  $\frac{103.07/\text{te}}{0.417}$

= Rs. 248.17/ton of coal

exposed

```
#include <stdio.h>
```

```
#include <stdlib.h>
```

```
// Define a struct for dragline calculations
```

```
typedef struct {
```

```
float cycleTime;
```

```
float bucketCapacity;
```

```
float utilization;
```

```
float availability;
```

```
float mechanical Availability;
```

```
float operating Hours;
```

```
// Add other relevant parameters
```

```
} Dragline Params;
```

```
// Function to calculate yearly production
```

```
float calculate Yearly Production (Dragline Params params) {
```

```
float production = (params.Bucket Capacity/params.cycle Time) * params.utilization* 0.719 * 0.733 * 0.8 * 83 * 365 * 60 * 60;
```

```
return production;
```

```
}
```

```
// Function to calculate ownership cost
```

```
float calculate Ownership Cost (float capital Cost, int years) {
```

```
float depreciation = 0.04 * capital Cost;
```

```
float average Annual Investment
```

```
= (years + 1) / (2.0 * years) *
```

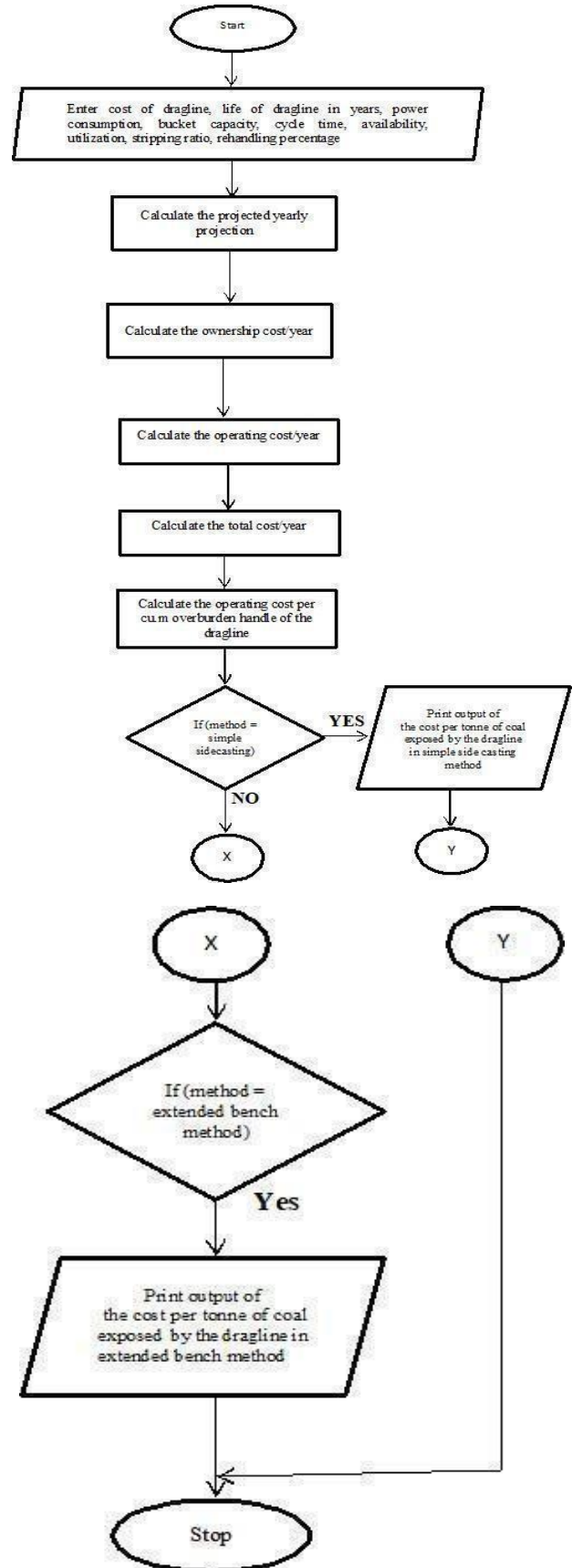
```
capital Cost;
```



```

float interest = 0.15 * average Annual Investment;
float ownership Cost = depreciation + interest;
return ownership Cost;
}
// Function to calculate operating cost (add implementation details)
float calculate Operating Cost () {
    // Add calculation logic here
    return 0.0; // Placeholder
}
// Function to calculate total cost (add implementation details)
float calculate Total Cost () {
    // Add calculation logic here
    return 0.0; // Placeholder
}
// Function to calculate overburden cost (add implementation details)
float calculate Over burden Cost () {
    // Add calculation logic here
    return 0.0; // Placeholder
}
// Function to handle coal exposure for the simple side casting method
void coal Exposure Simple () {
    // Add implementation details
}
// Function to handle coal exposure for the extended bench method
void coal Exposure Extended () {
    // Add implementation details
}
int main () {
    DraglineParams params;
    float capitalCost;
    int years;
    char method;
    // Input parameters
    printf("Enter capital cost: ");
    scanf("%f", &capital Cost);
    printf("Enter number of years: ");
    scanf("%d", &years);
    printf("Enter type of method (s for simple sidecasting or e for extended bench method): ");
    scanf(" %c", &method);
    // Calculate and display results
    float yearlyProduction = calculateYearlyProduction(params);
    printf("Yearly production: %.2f\n", yearlyProduction);
    float ownershipCost = calculateOwnershipCost(capitalCost, years);
    printf("Ownership cost: %.2f\n", ownershipCost);
    // Add calls to other calculation functions and coal exposure methods based on user input
    system("pause");
    return 0;
}

```



[Fig.3: Workflow to Assess Whether or not Rehandling is Needed While Constructing a Dragline Bench (by Limiting the cut-width to be Constant)]

# Overview of Line Excavator (Dragline) Role in Optimization of Production in Surface Mines

For the Extended Bench Method, Output 1:

Entered input:

Dragline cost: Rs. 1002 million

Total number of years:25

Consumption of power:13.85 KWH

Capacity of bucket:24 Cu. m

Time taken for one cycle:60.7 s

Rate of availability:0.7898

Rate of utilization:0.7053

Ratio of stripping:2.5

Rehandling percentage:0.41

To choose between the extended bench approach (e) or basic sidecasting (s)

Output 1:

Dragline's annual output = 2.87 M Cu. m.

The dragline's annual ownership cost = 118 million.

The dragline's yearly operating expenses come to Rs. 114.71 million.

The dragline incurs a total annual cost of Rs. 242.7 million.

Rs. 81.03 is the operating cost per cubic meter of overburden management.

According to draglines, the cost of coal is Rs. 285.76 per tonne.

Output 1 for the process of sidecasting:

Entered Input:

Dragline cost: 300 million rupees

Total number of years:25

Utilization of electricity:9.17 KWH

Capacity of the bucket:10 Cu. m

Time taken for one cycle:66.35 s

Rate of availability:0.8533

Rate of utilization:0.75

Ratio of stripping: :3

Rehandling percentage :0

To decide between the extended bench technique (e) and simple sidecasting (s),

Output 2:

1.24 million cubic meters of draglines are produced annually.

The dragline costs Rs. 35.45 million to own each year.

The dragline incurs an annual operating cost of Rs. 66.055 million.

The dragline's annual total expenses come to Rs. 101.451 million.

Each cubic meter of overburden handling incurs an operational cost of Rs. 81.46.

A dragline exposes coal for Rs. 244.40 per tonne.

**Table I: Dragline Productivity Parameters by CMPDI Guidelines**

Particulars	Recommended values
Swelling factor	0.719
Filling factor	0.733
Positioning factor and machine travelling	0.8
The total number of shifts in an entire day	3
The total number of hours in an entire day	8
The total number of days in an entire year	365

**Table II: Specifications of the Singareni OCP-I Dragline**

S. No.	Parameters	Details
1	Dragline (boom (m) and bucket (m <sup>3</sup> ))	24/96
2	Made	Rapier & Ranson (England)
3	Maximum radius of operation (m)	88
4	The bench height	30-35
5	Cutting breadth (m)	60
6	The slope of the high wall (degrees)	70
7	The slope (in degrees) of the bench	60
8	Angle of repose (in degrees)	38
9	Depth of digging	25
10	Reach of the dragline	73
11	Work methodology	Extended bench method
12	The coal seam thickness	4.5

**Table III: Specifications of the Samaleswari Dragline**

S. No.	Parameters	Details
1	Dragline	10/70
2	Made	Russian
3	Maximum radius of operation	58
4	Height of a bench	35-41
5	Cutting width	50
6	High wall slope	70
7	Bench slope	60
8	Angle of repose	38.5
9	Digging depth	37
10	Reach of the dragline	58.77
11	Work methodology	Simple side casting
12	The thickness of the seam of coal	24

**Table IV: Dissection of the Working Hours**

Name of the Mine	Equipment	Scheduled Shifts Scheduled Hrs (SSH)	Working of total Hrs (WH)	Maintenance time Hrs (MH)	Breakdown Hrs (BH)	Idle time Hrs (IH)
OCP-I Singareni	24/96	720	508	119	33	61
The Samaleswari	10/70	720	541	91	31	60

**Table V: The Mean Overall Cycle Time Yields**

Mine	Equipment	Standard cycle time (s)	Observed cycle time (s)
The Singareni	24/96	60	61.71
The Samaleswari	10/70	60	66.35

**Table VI: Factors Affecting Availability and Use**

Mine	Equipment	Factor of Availability	Factor of Utilization
OCP-I Singareni	24/96	0.7899	0.7041
The Samaleswari	10/70	0.8332	0.751

## VI. RESULTS

- The dragline at Singareni OC-I is estimated to generate 2.817 million cubic meters annually.
- Samaleswari's dragline is planned to generate 1.253 million cubic meters of coal annually.
- This is Rs. 81.670 for the Singareni OC-I dragline (24/96),



which has an annual capacity of 2.817 million cubic meters.

- The Samaleswari dragline (10/70) produces 1.253 million cubic meters annually, with an operational cost of Rs 82.2 per m<sup>3</sup> of overburden handled.
- The OC-I dragline at Singareni (24/96) has an estimated cost of 285.781 rupees per tonne of coal.
- The dragline (10/70) at Samaleswari costs about Rs. 247.172 per tonne of exposed coal.

## VII. CONCLUSION

The following variables impact the cost and output of dragline coal:

- More idle time might be caused by a lack of blasted dirt pile, operator availability, skill, and performance.
- Disruptions during breakdowns.
- Higher repair costs and breakdowns.

### Scope for improvement: -

Factors affecting dragline coal output and cost include: -

- Insufficient blasted dirt pile, operator availability, ability, and performance may lead to longer idle times.
- Disruptions during breakdowns
- Higher breakdown and repair costs  
Utilize blasting methods like the i-kon system to increase dragline productivity and maximize casting.
- The balancing diagram should be the focus of attention.
- Hiring skilled workers.
- Machine maintenance should be a significant focus.
- Used a backup dragline operator to reduce unpredictability in performance.
- A proper key cut (position, width, depth, etc.) and box cut are required.
- Improved preventative maintenance to save downtime and expenses.
- Improve communication systems.
- Spraying water on the dump reduces dust production.
- Shortening the dragline cycle time ensures efficient manufacturing.

## DECLARATION STATEMENT

After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

- **Conflicts of Interest/Competing Interests:** Based on my understanding, this article does not have any conflicts of interest.
- **Funding Support:** This article has not been funded by any organizations or agencies. This independence ensures that the research is conducted with objectivity and without any external influence.
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- **Author's Contributions:** The authorship of this article is contributed equally to all participating individuals.

## REFERENCES

1. Zhang, Z., Zhang, R., & Sun, J. (2023). Research on the Optimization of Open-Pit Mine Cast Blasting Parameters Based on the Optimal Economy of Dragline Stripping Technology. *Applied Sciences*, 13(19), 10888. DOI: <https://doi.org/10.3390/app131910888>
2. Appaji, D., Reddy, K. C., & Yogendra, G. (2024). DRAGLINE PERFORMANCE CARE STUDY IN INDIAN COAL MINES. *Hunan Daxue Xuebao/Journal of Hunan University Natural Sciences*, 16-26. <https://johuns.org/index.php/JHUNS/article/view/40/35>
3. Seervi, V., Kishore, N., & Verma, A. K. (2023). Critical Analysis of Tandem Dragline Performance in Open-Cast Coal Mines: A Case Study. *Journal of The Institution of Engineers (India): Series D*, 104(1), 391-402. <https://ui.adsabs.harvard.edu/abs/2023JIEID.104..391S/abstract>
4. Xiao, S., Dong, G., & Wang, H. (2020). Dynamic capacity balance between stripping and mining of a dragline stripping system. *International Journal of Coal Science & Technology*, 7, 380-387. <https://link.springer.com/article/10.1007/s40789-019-00293-0>

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