第 51 卷第 03 期
2024 年 3 月

湖南大学学报（自然科学版）
Journal of Hunan University（Natural Sciences）

Vol. 51. No. 03.
March 2024

Open Access Article

DRAGLINE PERFORMANCE CARE STUDY IN INDIAN COAL MINES

Dasari Appaji[#1], K Charan Reddy[#2], G Yogendra[#2], P saikiran[#2],G Srinivasa Rao[#2]
[#1]Assistant Professor, [#2]UG Scholar, Department of Mining Engineering
Godavari Institute of Engineering & Technology (A), Chaitanya Knowledge City, Rajahmundry, Andhra Pradesh, India.

ABSTRACT: Draglines have been used solely in the coal mining sector as strippers or coal extractors for several decades now. Given its intrinsic advantages over competitors, this equipment can be used endlessly to produce great production at minimal cost. As a result of aggressive coal production ambitions (up to 10 MT/year), India's vast surface mining operations, such as Jayanth and Bina, are boosting demand for technologies capable of rapidly removing massive amounts of overburden. As a result, shovel mining has been replaced by dragline mining as the primary method for overburden excavation in surface coal mining. Coal India Limited (CIL) recently introduced standardized draglines in two different diameters for their mines: 10/70 and 24/96. The dragline runs seven days a week and is critical to the operation of most mines. In many coal mines, the dragline is the only primary extraction apparatus, and the mine's production is completely dependent on its good operation. As a result of these considerations, dragline design is the only area that necessitates a greater emphasis on developing components with greater dependability and predictability; this allows for the scheduling of component replacements and restorations during periods with minimal negative effects on the overall mining operation. Before installing draglines in mines, numerous factors must be considered to guarantee that the proper diameter is chosen. The operation and mechanisms of the heavy earth moving machine dragline (HEMM) have been detailed.

KEYWORDS: *Dragline, Minimum, Mines, Installation, Machinery.*

1. INTRODUCTION

Draglines use heavy-duty machinery to mine minerals. These massive sediment and coal haulers are being built on mine sites.The object comprises of a large container propelled by wire rope from a crane. Chains and ropes are used to move the container.Horizontally, a drag rope pulls the pail assembly, while electric motors power the hoist.

Its top speed is limited to a few meters per minute. Longer journeys generally require disassembly. Mining draglines are rarely relocated due to their vast covering capabilities. Using a dragline to remove material from beneath the foundation is a viable option.Although inefficient, it may excavate above itself. It is not proper to move debris using a shovel.Many miners choose draglines because of their durability and low trash disposal costs.

Despite their particular application, their dig-depth, boom length, and boom height are limited.Draglines with expanded booms and container capacities are required to meet production needs.To lower cost per cubic meter, the dragline must be operated in a systematic manner, which requires vigilant monitoring, intelligent overburden control, proactive dragline maintenance, and

Received: February 04, 2024 / Revised: February 27, 2024 / Accepted: March 06, 2024 / Published: March 11, 2024

About the authors：Dasari Appaji

Corresponding author- Email:

suitable bench elevation. Drag must remove large amounts of overburden quickly and effectively in order to meet the increasing demands of coal extraction. This activity works best when done with lines.

2. REVIEW OF LITERATURE

Coal has long been a major source of energy. Coal has long been used in HVAC systems, transportation, and manufacturing. Currently, its major role is as a propellant for generating electricity. America, China, and Russia have the greatest coal reserves. The United States holds 27.6% of the world's confirmed and extractable coal reserves, totaling 237 billion tonnes. In 2011, the United States utilized 909.9 million tons of coal, according to the EIA. In the same period, 992.8 million tons of coal were produced in the country. According to BP (2012), the United States produced 13.5% of the global coal supply in 2010.

Coal is classified as thermal, metallurgical (coke), and industrial in the United States. The majority of power plant coal (90 percent) is steam coal, which is used to generate industrial heat and steam. As power plants use natural gas instead of coal, the price of natural gas determines this proportion. Conventional iron smelting blast furnaces use metallurgical coal or coke to manufacture steel. Industrial coal is used as a fuel in cement and limestone plants, food processors, paper mills, and other production facilities (World Energy Council, 2010).

Economic factors, the environment, coal seam depth, thickness, and dip all have an impact on method selection for coal mining. There are two types of coal extraction methods: surface and subterranean. In 1973, the United States' surface and underground coal mining output was evenly split. Large-scale mining has led to increasing output, particularly in surface coal mines. In 2011, surface coal mines produced 68% of the world's coal (US Energy Information Administration, 2011b). Increased coal demand mandates that the mining industry boost productivity. As is well known, larger surface coal mines with more complex control systems and equipment have higher productivity (Bonskowski, Watson, and Freme, 2006). Coal's relevance is determined by its environmental impact and the efficiency of its surface extraction.

According to the US Department of Energy, the mining industry used 365 billion kWh in 2007. Table 1-3 details the annual energy usage by commodity. Coal miners consume an estimated 142 billion kWh of energy per year. According to data from the US Department of Energy (DOE), coal mine material handling equipment burned 13.3 billion kWh per year in 2007. Coal miners spend $884 million on energy for material handling each year. The average cost of industrial energy in 2011 was 6.65 cents per kilowatt-hour, according to the US Energy Information Administration in 2012. This accounts for 28% of yearly mining energy costs in the United States.

Draglines, which cost between $50 million and $100 million, are the most common type of mining equipment. (Humphrey, 1990). Dragline mining is efficient, cost-effective, and adaptable to different overburden depths and materials.

Typically, surface coal mines use power for draglines. Because of the significant initial investment, rising energy costs, and mine profitability's severe sensitivity to dragline productivity, mines gain from increases in dragline productivity and efficiency. G. Lumley (2005) estimates that a one-percent increase in dragline productivity in Australian coal mining is worth $50,000 to $2,300,000.

Optimizing a mine's dragline propulsion mechanism for energy efficiency and dragline selection can be expensive. Mine planning mitigates the energy-efficiency impact of operational factors. The energy efficiency of a mine is limited by unpredictable geological constraints. Operator behaviour has an impact on the energy efficiency of mining loading equipment.

Bogunovic (2008) and Komljenovic et al. (2010) revealed that, despite equal working conditions, dragline productivity varies greatly between operators. Understanding the relationship between operator actions and energy efficiency has the potential to increase both efficiency and cost. An substantial body of research is needed to objectively analyze the impact of operator methods on dragline energy efficiency and identify the variables contributing to these disparities. The operator's skill and experience play a crucial role in the dragline's effectiveness. The current work uses statistical methods to investigate dragline energy efficiency and operator behavior. Create a technique to assess the impact of operator behavior on the energy efficiency of a dragline.

Exxon Mobil (2013) predicts population increase of more than 25% between 2010 and 2040, as well as annual economic expansion of 2.8%. If current trends continue, global energy consumption would rise by 50-80% over 1990 levels by 2020 (Orner, 2008). To reduce energy consumption, it is important to consider the benefits of energy efficiency. According to the Energy Information Administration (EIA 2011c), fossil fuels accounted for 77.60% of total energy output in the United States. Refer to Figure 2-4.

In addition to greenhouse gases, the combustion of fossil fuels produces volatile organic compounds, sulfur dioxide, nitrogen oxides, and heavy metals. CO, CO2, SO2, and NOx emissions cause global warming. Increased energy use has a negative impact on both the environment and public health.

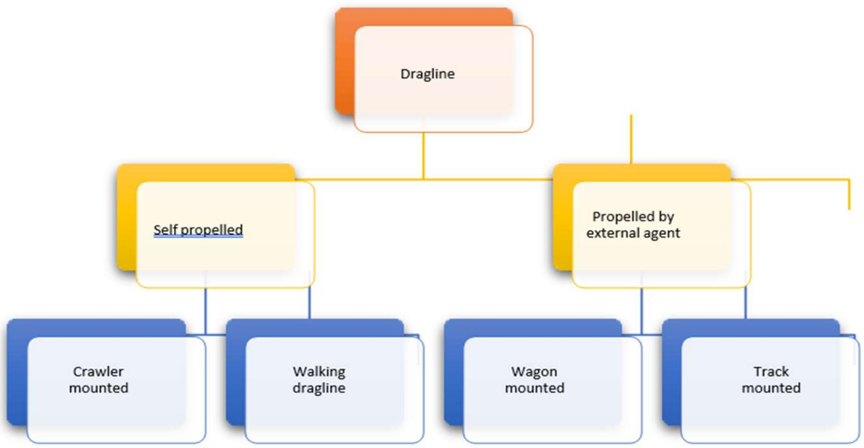
Improving energy efficiency is a well-established and cost-effective way to meeting the world's growing energy demand, lowering carbon dioxide emissions, and mitigating the environmental consequences of energy production. Recently, China, the United States, the European Union, and Japan have undertaken efforts to improve energy efficiency and so reduce energy consumption. These actions were taken in response to the 2012 International Energy Agency (IEA) and the 2008 Orner guidelines. Efforts to enhance energy efficiency will reduce the amount of energy required to create one unit of GDP, slowing the rise in global energy demand. Ristic and Jeffeni (2012) claim that energy efficiency may lower world energy demand by 20% utilizing existing technologies. Figure 2-5 illustrates the link between energy efficiency and global consumption.

Energy accounts for 20-40% of mining expenses (Mielli & Wallace, 2012). Energy consumption determines a company's greenhouse gas emissions profile, which is currently voluntary but could become mandated in the United States (U.S. Energy Information Administration (EIA), 2013). For regulatory reporting purposes, energy efficiency in mining operations reduces costs, increases profitability, and lowers emissions. Similar services or goods are created through efficient processes that use fewer resources (Dincer & Rosen, 1999; Mielli, 2011; Steele & Sterling, 2011; World Energy Council, 2010).

Improving energy efficiency necessitates a competent energy management system that analyzes energy usage to find possible areas for conservation and establishes the relationship between energy production and consumption. Efficient energy efficiency schemes require precise assessment of energy consumption. The lack of comprehensive data on energy use in mining operations makes it difficult to determine the best solutions for improving energy efficiency.

3. BACKGROUND WORK

CLASSIFICATION OF DRAGLINE: -



CONSTRUCTION OF WALKING DRAGLINE

Discharged intermittently while walking draglines excavating. The boom of the truck's excavator is the longest. The boom length ranges from 9 to 96 meters. Unlike alternative excavators, the container is not supported by the frame. The name "Dragline" machine refers to the draw or drag of the bucket in the direction of the material. Using the container becomes more complicated.
In optimum mining conditions, these excavators remove overburden efficiently and affordably. Manufacturers produce these devices in a variety of capacities and dimensions to suit the chosen equipment and parameters. It is able to dig beneath the operating surface. The illustration below depicts such an apparatus. Using a boom lift cable, a dragline structural steel attic structure is raised or lower. The drag cable is attached to the bucket, propelling it toward the machine and the dread at the boom base.

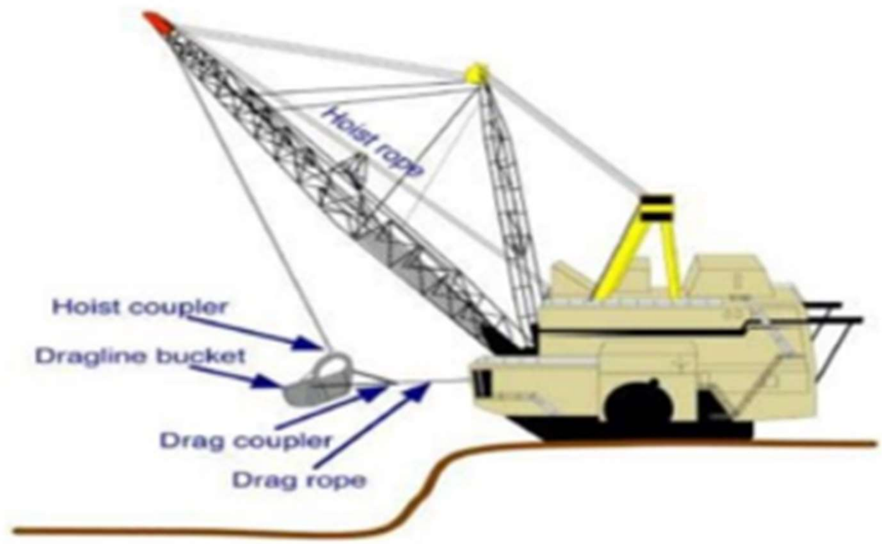


Fig-1:walking dragline

The container is filled with loose debris, which the hoist cable raises and the drag cable lowers. Subsequently, the substance is moved to vehicles, railroad wagons, or the spoil dump. Draglines are used during over casting for direct handling and re-handling of overburden material because they are an inexpensive way to remove obstructions.

4. DRAGLINE STRIPPING METHODS

SIMPLESIDE CASTING METHOD:-

- This is the simplest type of strip mining, in which surplus material is extracted in a series of parallel strips.
- The strips are created in a sequence of segments.
- Once the coal mineral has been taken, the overburden from each strip is dumped in the void left by the previous strip.
- A usual approach is to start the excavation of each block by making a wedge-shaped incision and aligning the dragline with the previously elevated wall.
- From this position, the device can easily mount a towering wall and ingest food.
- The closest high wall impacts the dragline at line 18, namely at the peak. As the excavation advances, the dragline is moved until it is aligned with the base of the new vertical wall.
- This approach allows for exact adjustments to the slope angle of the new high wall.
- The width of each stripe is frequently chosen to aid in the transfer of material from one key cut to the preceding cut, minimizing the need for further handling.
- After finishing the key cut, the dragline is positioned near the prior high wall edge, allowing it to excavate the block faces from a closer distance.
- Optimal casting can be accomplished straight from the coal bench by carefully determining the proper bench height, block width, and reach.
- The spoil pile, on the other hand, frequently reaches the highest position of the coal seam due

to the advantages indicated above.

- The accompanying benefits are equally clear.Rehandling is discouraged due of the potential negative impact on operational efficiency and financial performance. Furthermore, the practice of advance benching using this method is being introduced as a result of the aforementioned reasons.
- The manner in which a dragline is used to remove material has a considerable impact on its productivity.
- In the illustrated example, the dragline aligns itself immediately above the material to be removed and swings in an arc ranging from 45 to 90 degrees to extract the material.
- A normal cycle time of 45 seconds is considered standard for this technique.

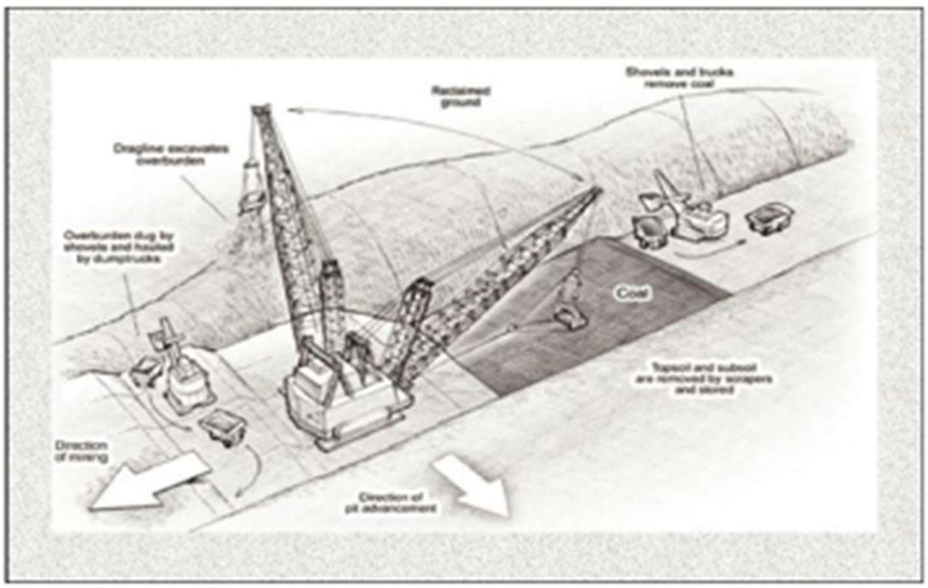


Fig-2: Simple Side Casting Method

DRAGLINE EXTENDED BENCH METHOD: -

- If the overburden depth or panel breadth exceeds the dragline's coal-sidecasting capability, an overburden bridge may form between the spoil and the bank, projecting beyond the dragline.
- The bridge extends an elongated settee from which the dragline operates.
- To speed up bridge construction, the material is either deposited directly with a dragline or lowered down the debris bank.
- Rehandling the bridge material is critical for ensuring its total removal from the coal's surface. Extended bench systems are compatible with a broad variety of pit geometry configurations.
- This technique allows the dragline to efficiently erect the bridge by removing material from the upper area of the bench. Following that, it goes towards the bridge and removes it from the coal surface.
- The primary dragline efficiently collects and distributes extra material throughout the previously dug region.
- Tractor-dozers or the secondary dragline itself are used to grade the material for the secondary

dragline bench.

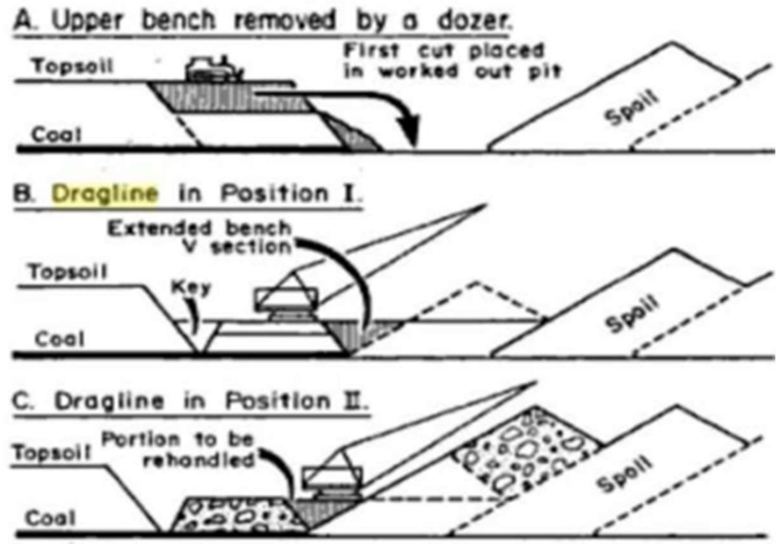


Fig-3:Dragline Extended Bench Method

- Following the initial removal of material from the high wall, the secondary dragline is deployed on the bridge to transfer the excavated debris.
- In a two-dragline system, one machine must match the pace of the other.
- As a result, when determining appropriate excavation depths, the mine design must take into account the capability of each unique mine.
- The principal dragline lifts the weight to the top of the initial stratum. Following the coal deposit's excavation, a microscopic portion became dormant within the hollow.
- Secondary draglines remove the massive upper layer till it reaches the third and final coal seam.
- The efficient design of extended bench systems is critical for reducing re-handling and increasing dragline productivity.

DRAGLINE PULL-BACK METHOD: -

At times, the amount of coal required for extraction surpasses the dragline's capacity to separate it using any of the aforementioned ways.

In this case, a second dragline might be attached to the spoil bank to aid in the entire extraction of the overburden while retaining an acceptable amount of trash.

Pull-back operations often require a greater amount of re-handling than extended bench techniques.

Alternatively, it could be used to level spoil piles while giving the principal dragline more spoil area.

When draglines put on the high wall fail to adequately control the surplus or inter burden, the pullback method looks to be a viable alternative.

However, given the inherent hazards associated with operational operations, it is necessary to properly evaluate the design of this process.

After heavy rain, steep inclines can be very dangerous.

Draglines are commonly used to recover debris from deeper coal seams than originally envisaged.

Sometimes spoil slopes' planned slope angles are not kept.

To address these concerns, a variety of ways for incorporating extra material into the trash bank have emerged.

5. DRAGLINE BALANCING DIAGRAM

A balancing diagram, as defined by Rai (1997), is a visual representation of an approach used to determine the optimal seating layout for a dragline. The goal of this installation is to optimize overburden accommodation in a decoated area while minimizing handling. The aims are to achieve a high coal exposure rate while maintaining slope stability.

The balancing diagram is used to determine the volume of overburden that may be accommodated in the de-coated region, as well as the percentage of overburden, re handling, and the amount of coal exposed by a dragline.

Furthermore, the dragline's cuts and spoil geometry are depicted in two dimensions on the balance diagram, together with the dragline bench's height and cut width. The india gram cross-sections can be used to establish the approximate sequence of cuts done by a dragline, such as the key cut (box cut), the initial cut adjacent to the key cut, and the beginning excavation.

Purpose of drawing balancing diagram:-

The interface displays segments divided by a dragline, such as the handled area, key cut, first cut, and first delve (subject to change depending on mode of operation).

The data presented includes the height of the dragline bench, the gradient's thickness, the width at which the draglines function, and a variety of slope angles.

Calculating the amount of coal exposure on a yearly, monthly, or daily basis.

The determination of the manpower distribution for each dragline, taking into account its annual production or cross-production,

Each dragline should have a sectional area proportionate to its annual output.

Calculate the percentage composition of the re handling proportion.

Determine the additional load that must be supported in the area where no covering exists.

Preparation of Dragline balancing diagram:-

To simplify notation, the cross-sectional area needing excavation to expose the coal seams A B C O might be denoted as BCDE. This area could be referred to as "first-dig" territory.

Let,A1=First-dig.................. (1)

A massive gantry mounted on the high face of the wall is currently removing the explosive material that surrounded the region above the original excavation. The dump FGKH's capacity to accommodate overburden is limited by the dragline's reach and the dump slope layout.

Let A2= Dump Area.............(2)

If S signifies the swell factor of the overburden material, then A1S is the literal area of overburden that an impoverished region must cover.

Let,A3= A1S-A2 .... (3)

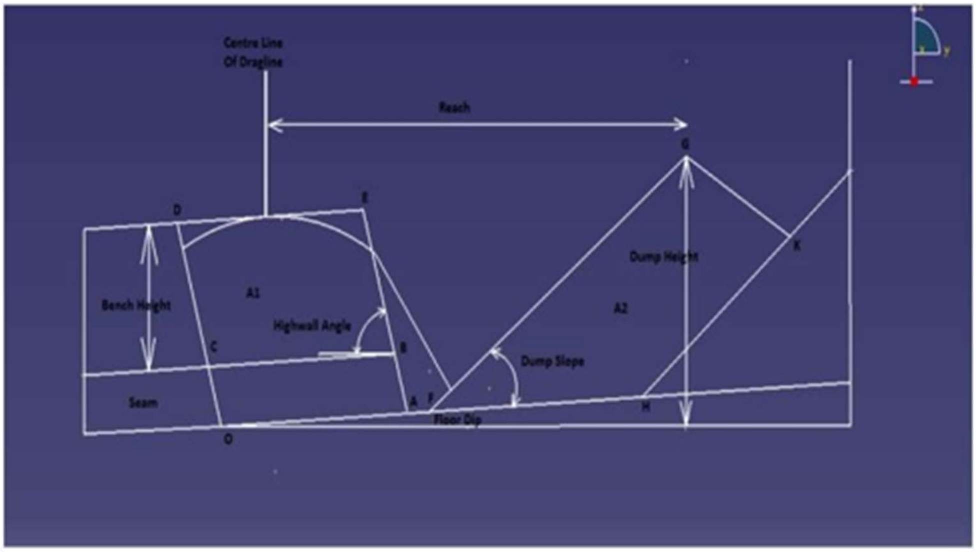


Fig-4: Balancing diagram for Total Side castingCase-1.WhenA3<0

The dump location cannot handle more waste than the initial amount that is currently accessible.These findings suggest that the initial quantity can be enhanced by either widening the cut or elevating the dragline bench. This is continued until the dump area equals the initial excavation losses.

Case-2.When A3=0

This is the most effective method for performing the direct dragline deployment technique.The most efficient procedure is simply sidecasting, which requires no material modification.Any increase in the height or width of the dragline bench would cause an increase in the first digit, which the dump cannot accommodate.

Case-3.When A3>0

These data suggest that around one-third of the loose top layer will remain as leftover material due to the dump's lack capacity to handle the total amount of overburden. There are two options for dealing with the leftover waste: relocate and eradicate it in a different site, or expand the landfill to make more space. Increasing reach can be accomplished by choosing equipment with longer reach capabilities.The selection of options is limited. Alternatively, the dragline might be moved to the dumpside to extend its reach.

In this situation, the extended bench approach was used to deploy draglines.

APPLICABLE CONDITIONS FOR DRAGLINE:-

It is recommended that ingredients have a maximum slope of one in six.

Seams should be free of flaws and other geological disturbances.

A quarry strike should not be less than one kilometer in length.

Seams that exceed 25 mm in thickness are considered undesirable.

An region with a high degree of elevation is judged unsuitable.

Following the detonation, excavation can readily be used to remove the overlying material.

MAINTENANCE OF DRAGLINE: -

The optimal running of a firm is dependent on its upkeep, which enhances output. Furthermore, it helps to keep the machinery as efficient and economical as possible.

- Break down Maintenance
- Preventive Maintenance
- Predictive Maintenance
- Scheduled maintenance
- Component-wise maintenance

6. CONCLUSION

Recent advances in productive or diagnostic maintenance systems have aided in the early detection of equipment problems. This capacity enables maintenance workers to proactively plan and assemble the necessary parts and skilled labor force for repairing and returning equipment to operating condition Given HEMM's increased scale, complexity, and fleet size, it is necessary to implement a regular preventive maintenance program to ensure optimal machine performance and extended machine availability. Starting with a simple assertion is sufficient because the concept requires little explanation at first. Despite its apparent simplicity, the technique must be followed meticulously.

Several case studies show that dragline equipment is an effective technique of minimizing unnecessary burdens, hence its use and implementation should be enhanced. Furthermore, this method has the potential to be further refined and expanded in the future.

REFERENCES

1. Acarog1u, 0., Ozdemir, L., & Asbury, B. (2008). A fuzzy logic model to predict specific energy requirement for TBM performance prediction. Tunnelling and Underground Space Technology, 23(5), 600--608. doi:l0.1016/j.tust.2007.11.003
2. Baafi, E. V, Mirabediny, H., &Whitchurch, K. (1995). A Simulation Model for Selecting Suitable Digging Method for a Dragline Operation. APCOM XXV, 9-14.
3. Coal production in the united states -an historical overview (pp. 1-19). Retrieved from http://www.eia.gov/cneaf/coal/page/coalyroduction_review.pdf British Petroleum (BP). (2012).
4. Drag1ine dynamic modelling for efficient excavation. International Journal of Mining, Reclamation and Environment, 2 3(1), 4-20. doi:10.1080/17480930802091166 Dessureault, S. (2007).
5. Drezner, Z., Turel, 0., &Zerom, D. (2010). A Modified Kolmogorov-Smirnov Test for Normality. Communications in Statistics-Simulation and Computation, 39(4), 693-704. doi: 10.1080/03610911003615816 Drives & Controls Services. (2003).
6. Exxon Mobil. (2013). The outlook for energy: A view to 2040. Gibbons, J.D., & Chakraborti, S. (2010). Nonparametric Statistical Inference (Fifth.).
7. Graham, J. W. (2009). Missing data analysis: making it work in the real world. Annual review of psychology, 60,549-76. doi:10.1146/annurev.psych.58.110405.085530
8. Johnson, R. A., & Wichern, D. W. (2007). Applied Multivariate Statistical Analysis. Prentice Hall.
9. Kizil, M. (2010). improving Dragline Productivity using a Diggability index as an indicator. Society for Mining, Metallurgy & Exploration, Inc. (SME), 134-141.
10. Little, R. J. A. (1992). Regression With Missing X's: A Review. Journal~~ American Statistical
11. Shapiro, S S, Wilk, M. B., & Chen, H. J. (1968). A Comparative Study of Yarious Tests for

Normality, 63(324), 1343-1372.

12. Zhu, Y. Q., & Yin, Z. D. (2008). A new evaluation system for energy saving based on energy efficiency and loss ratio. International Conference on Sustainable Energy Technologies (ICSET), Singapore: IEEE, 121-124.