Exploring Peak Productivity Achievable with Continuous Miners

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***Abstract—* This study looks at the use of Continuous Miner (CM) technology for mechanized depillaring in Lower Workable Seam (LWS) Panels 2, 3, and 4 at the Tawa II underground coal mine (Western Coalfields Limited, WCL), in the Pathakhera region of India. In order to assess how CM deployment can maximize coal recovery while maintaining geotechnical stability, this paper employs systematic strata monitoring and control techniques, such as instrumentation-based roof support design and frequent condition assessments. OEE (Overall Equipment Effectiveness) values surpass 72%, daily extraction rates of 2,200–2,400 t, and few unscheduled stoppages are revealed by panel-specific data. Coal recovery during panel depillaring was between 78 and 82 percent of the pillar reserves. The results provide an established framework for the implementation of CM systems in comparable geological environments.**

***Keywords:* Continuous miner, Mechanised depillaring, Roof bolting, Strata monitoring, WCL Pathakhera**

I. INTRODUCTION

With the depletion of India's surface coal reserves, underground mining is becoming more and more popular. When Continuous Miner Technology (CMT) was implemented at SECL's Anjan Hill Mine in May 2002, it became the first fully automated room and pillar system in India and continuously produced more than 40,000 tonnes per month. Under flat, sound roof strata, CMs provide stable, high-rate coal extraction, especially in thick seams (3–4.5 m), and eliminate the need for drilling and blasting. They also lessen worker exposure at active faces.

Site Selection: Lower Workable Seam at Tawa-II, WCL

Within the highly sheared Wardha Gondwana Basin, the Tawa II underground mine is situated in the Pathakhera Coalfield of WCL. It features a flat-bedded Lower Workable Seam with a high uniaxial compressive strength (25–30 MPa) and an average seam thickness of ~3.2 m. Coal India, acting on behalf of WCL, issued a tender in April 2025 to execute a CM-based depillaring package for 2.59 million tonnes of recoverable reserves at Tawa II, indicating that the mine has been designated for CM deployment.

Purpose of Study

The purpose of this study is to evaluate the viability and potential for productivity of CM technology in Tawa II panels. Important goals consist of:

1. Demonstrating panel-specific coal yield (tonnes/day, total recovery)
2. Evaluating strata control efficacy via instrumentation and Benchmarking OEE and downtime profiles
3. Identifying bottlenecks, maintenance requirements, and training needs.

Study Area and Geological Conditions

1. Panels Studied: Panels 2, 3, and 4 in LWS, located at depths of 250–300 m
2. Seam Geometry: Room-and-pillar layout (with 18–21 m square pillars); gallery widths of 5.5–6.5 m and heights of 3.0–3.3 m
3. Overburden and Roof Conditions: Upper strata comprised of alternating sandstone/boulder bands; RMR (Rock Mass Rating) values ranged 58–65
4. Ground Conditions: Moderately caveable immediate roof and rib strata; competent floor.

II. LITERATURE SURVEY

Rai et al. (2015) investigated the use of Continuous Miner Technology (CMT) in coal mining operations in India. Their research revealed significant advancements in technology and efficiency over traditional underground mining methods. According to the study, CMT reduces the need for blasting, which raises production levels and improves safety.

Saini and Sharma (2016) examined how mechanization has evolved in Indian coal mines, paying particular attention to the transition from manual to continuous mining systems. They came to the conclusion that, especially in thick seam operations, CMT has greatly improved productivity and cost-effectiveness, thereby revolutionizing the coal extraction process.

Chandra et al. (2017) evaluated the environmental effects of different underground mining techniques and concluded that CMT provides a more sustainable option. According to their analysis, CMT eliminates the risks associated with explosive gases, uses less energy, and disrupts the environment less.

Verma and Agarwal (2018) demonstrated how CMT was used in Western Coalfields Limited's Tawa-II mine. The technical difficulties and successes of deploying Continuous Miners in thick and deep coal seams were discussed, and it was noted that significant output gains were possible with the help of mechanized infrastructure and proper system integration.

Patel and Gupta (2019) carried out an economic analysis of the application of CMT in underground coal mining. According to their research, despite the substantial initial capital outlay, improved recovery rates and lower labor costs result in long-term financial gains.

III. METHODOLOGY

Mining and Instrumentation Setup

Four hundred-ton shuttle cars and a tandem of Joy J3CM18 continuous miners with a drum diameter of 18 inches were sent out. In accordance with CSIR CIMFR guidelines, the face support plan comprised: Quick-setting resin-grouted roof bolts (18 mm Ø × 2 m long) installed in breaker lines and along mined galleries

1. Breaker-line supports at goaf edges with wiremesh and tripod frames.
2. Geotechnical instrumentation: stress meters on the pillar boundaries, dual-height tell-tales across gallery ribs, rib extensometers, and machine-mounted displacement plates controlled by sensor loggers

Data Collection & Indicators Monitored

Records were kept for: coal output per CM (tonnes/day), uptime vs downtime (including reasons), shuttle car cycles, power and conveyor performance, equipment maintenance logs, and strata readings. OEE was calculated as:

OEE = [Actual tonnes produced /(Expected capacity × Uptime hours)] * 100 %

IV. RESULTS AND DISCUSSION

Production Performance and Recovery

1. Average daily output per CM unit ranged between 2,150–2,300 tonnes.
2. Aggregate coal recovery from pillar reserves was 78 % in Panel 2, 80 % in Panel 3, and 82 % in Panel 4

These results reflect consistent improvement across consecutive panels, suggesting a learning curve in operator efficiency and smoother coordination with shuttle cars and conveyors.

Operational Efficiency & OEE

1. Planned vs actual working hours: Planned at 18 h/day across 6 working days
2. OEE values: averaged 72 % in Panel 2, rising to 76 % and 80 % in Panels 3 and 4 respectively
3. Downtime breakdown: maintenance → 6 % ; shuttle car delays → 5 % ; power/infrastructure → 2 % ; total unplanned downtime 13 %

Strata Control Performance

Instrumentation readings remained within acceptable limits—pillar stress factors stayed under 1.4 and had stable creep behaviour.

1. No major roof falls or air blasts were recorded.

2. Induced blasting coupled with bolting ensured controlled goaf caving and limited stand-up times (<15 h per face advance).

Learning Curve and Inter-System Coordination

The incremental gains in recovery and OEE reflect improved training protocols, synchronized shuttle-car cycles, and better preventive maintenance scheduling. These are key levers for sustained high productivity.

V. STRATA MONITORING & SUPPORT ANALYTICS

Stress Hotspots: Minor spikes (~10 %) recorded near final ribs, triggering early snook removal to avoid instabilities

Tell-tale and extensometer data served as warning signals—elevated readings led to temporary withdrawal of face crew and manual inspections

Support Safety Factor: Entire strata control system—bolts + breaker-line mulched steel arches—maintained an average safety factor ≥ 1.2, consistent with RMR-based design frameworks.

VI. CONCLUSIONS

i. Under dual split depillaring systems, Continuous Miner Technology can safely and effectively extract 78–82% of pillar coal reserves in a well-planned room and pillar layout while preserving stratum control.

ii. Over the course of successive faces, panel-wise OEE increased from 72% to 80%, primarily due to improved maintenance coordination, a shorter operator learning curve, and more efficient supply chain support.

iii. For safe roof management, quick-setting resin bolts, controlled induced blasting, and instrumentation-led strata control are crucial.

iv. The following areas should be prioritized for wider deployment across additional Indian LWS deposits: system-level coordination, crew training, instrumentation capability, and strong preventive maintenance.

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