

# Mass production from underground developed coal pillars by Continuous Miner Technology– a safe, sustainable and cost effective method: A Case Study

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**Abstract** - In Indian underground(UG) coal mines developed most of the mines with Bord and Pillar method of mining, the coal reserves locked up in the pillars has been extracted either by manual or by semi mechanization such as SDLs/LHDs. The rate of extraction is less in these methods which involves lot of time apart from exposure of manpower at the dynamic work place. To provide better strata control and to get mass production by introducing the Continuous Miner(CM) Technology for faster rate of extraction from the UG developed coal pillars. SCCL also introducing the CM Technology will aim at faster rate of extraction with mass production varies from 1000T – 1500T with less cost of production and more safety. Few methods of extraction of UG developed coal pillars by CM Technology, facing the strata control issues like roof dilation, load on pillar, induced stresses in the coal pillar and mechanization deployed in UG are discussed in this paper.

**Keywords** —SCCL-singareni collieries company limited, CM-continuous miner, UG-underground, LHD-load haul dumper, SDL-side discharge loader, DHTTs-duel height telltales, RTT-rotary telltale, AWTT-auto warning telltale, OMS-output per man shifts. LT-lakh tonne.

## I. INTRODUCTION

Most of the underground mines in SCCL were developed with Bord & Pillar method either by manual mining or by using SDLs/LHDs. The locked up coal reserves in the pillars is being extracted by deploying SDLs/LHDs with caving or stowing method. In general, the production expected from a mine having SDLs/LHDs is to the tune of 3-4 Lakh Tons per annum with low OMS of 0.9 to 1.3.

In view of the huge losses incurred from UG Mines, SCCL is now planning to enhance the production by introducing high mechanization such as CM technology. This CM technology is being implemented in some of the new mines and also in some of the old mines, where development was done with Bord & Pillar mining to step up the production<sup>1</sup>.

In SCCL, GDK 11 incline is one of old mines in the company, where the lot of coal reserves has been locked up in developed pillars especially in No.1 Seam. The CM Technology was introduced in No.1 seam in the year 2008. The production was achieved 4.69LT per annum with the 4.0LT target production from the CM panel with caving method. This CM technology facilitates achieving faster rate of extraction.

## II. METHOD OF WORKING

### 2.1 Heightening & widening of galleries:

The thickness of no.1 seam is varying from 5.5m to 6m. The development of galleries and pillars was done in the past by using drilling & blasting with manual mining. The gallery dimensions were about 2.7m height and 4.2m width with sand stone roof leaving balance coal in the floor. Some of the galleries were developed along middle section leaving about 2.1m coal in the roof and about 0.8m coal in the floor.

To facilitate movement of CM equipment, a gallery dimension of 3.5m height X 6m width is required<sup>2</sup>. Hence, it is required to heightening & widening of the galleries before starting the extraction of pillars.

The galleries which were developed along sand stone roof are heightened up to 3.5m by taking 0.8m coal from the floor. These galleries will be widened to 6m by taking about 0.9m coal on either side of the pillar.

The galleries which were developed along middle section will be heightened up to about 4.8m (sand stone roof) by taking 2.1m coal in the roof. These galleries will be widened to 6m by taking about 0.9m coal on either side of the pillar.

**2.2 Split and fender method:**

The pillars will be split in to 2 halves by driving a dip split gallery in the middle of the pillar to form 2 fenders. These fenders will be extracted by driving slices at an angle of about 70 degrees. The ribs will be reduced judiciously.

**2.3 Fish bone method:**

Some of the pillars having less dimensions which in turn having less factor of safety are extracted by fish bone method. In this method, the pillars are not split in to 2 halves. Slices are driven in to the pillar from the original dip gallery and level gallery. The ribs will be reduced judiciously.

**2.4 Straight line of extraction:**

Pillars are extracted in straight line one after the other starting from the dip side in bye most pillar. The line of extraction is retreated from dip to rise as shown in the Fig.1.

**III. RESULTS & DISCUSSION**

In every CM panel designs mainly depends on five parameters.

- i) Incubation period of coal,
- ii) Rate of production,
- iii) Width & length of the panel.
- iv) Roof RMR for caving pattern of the roof,
- v) Geological features like, faults, folds, joints, water seepage etc.

In this mine, the incubation period found to be 18months and the width of the panel is maintained varying from 120m to 150m and length of the panel about 600m to 650m.

The rate of production varies from 1000T to 1600T in a day with good roof having caving index.

The availability of geological features in the panel are additional advantage to retreat the panel with faster rate of extraction.

The workings of panel A4 are shown in Fig.1. The total reserves in the panel are about 5.4LT, where as extractable reserves are about 4.2LT with 76% of extraction. The panel is completed within a period of about 10-12 months.

**3.1. Details of No. A4, CM Panel in no.1 seam:**

S.No	Particulars	
1	Depth, minimum	: 177m
2	Depth, Maximum	: 235m
3	Size of the panel	: 120m X 600m
4	Area of the Panel	: 7200, m <sup>2</sup>
5	No of pillars	: 58
6	Size of the pillar	: 32X35
7	Status of Under laying 1seam	: Virgin
8	Status of Under laying 2seam	: Virgin
9	Status of Under laying 3seam	: Virgin

**IV. SUPPORT SYSTEM IN CM PANEL**

**4.1 Support of Roof:**

The sand stone roof is supported with roof bolts made of Fe600 steel having 1.8m long with resin capsules in a grid pattern of 1.5m X 1.5m. The roof in the junctions of supported with 2.4m long roof bolts with resin capsules with a grid pattern of 1.2m X 1.2m. The roof at the junctions is also supported with 5m long flexi bolts wherever required.

Goaf edge breaker line supports are fixed with 2.4m long roof bolts in a grid pattern of 1.0m X 1.0m in two rows.

**4.2 Support of Sides**

The sides are supported with GRP bolts of 1.8m long fixed in a grid pattern of 1.5m X 1.0m with plastic wire mesh.

**V. STRATA CONTROL IN THE PANEL**

In every CM panel must be prior approval of SCAMP and instrumentation plan for that depillaring panel in the mine by the scientific or internal agency study by the DGMS authority in India.

Accordingly in the CM panel, the following instruments are being used for strata monitoring in the CM panel<sup>3</sup>. Fig.1 shows the instrumentation plan<sup>3</sup> of the CM panel no A4.

**5.1 Dual height Tele Tales.**

Dual height telltale (DHTT) is an instrument for measuring the dilation of the strata. It has two anchor points. DHTTs proposed to be installed at every junction after immediately widening and heightening the existing gallery. One point shall be installed within the length of a bolt i.e. 1.8 m (1.5m from the roof level) and the second point shall be installed at a distance of 5.0 m from the roof level.

Continuous monitoring shall be done after installation. The readings shall be taken daily basis and it should be properly recorded in the hard bound register. If the dilation is beyond the bolt length with a value more than 25 mm then strata control officer should be informed and flexi bolts/cable bolts shall be installed. If it is more than 50 mm then immediately restrict the gallery/junction and secure the area with proper support under the supervision of strata control officer.

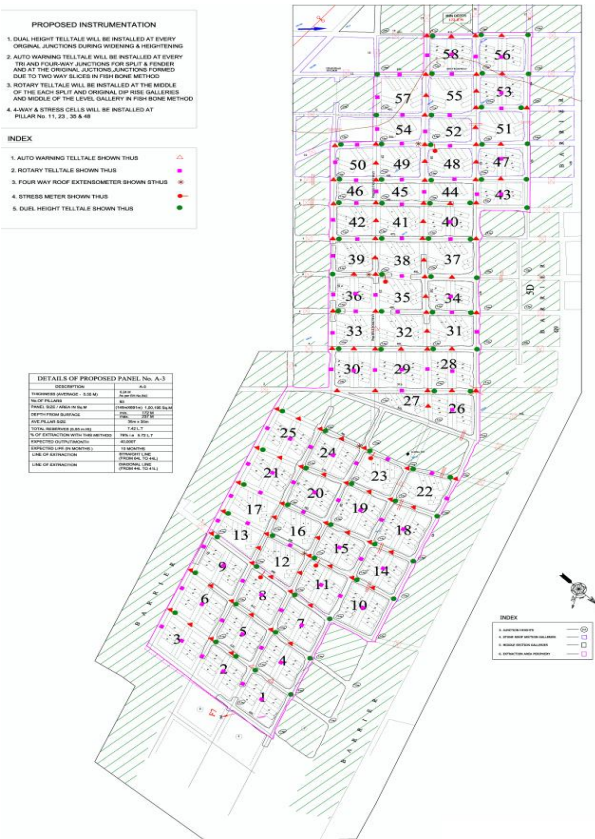


Fig.1 Layout of CM Panel no.A4

**5.2 Rotary Tele Tales.**

Rotary telltale (RTT) also gives the relative movement between the strata in the roof<sup>3</sup>. It is more sophisticated and can measure the movement of strata in millimeter. It magnifies vertical displacement into a rotational movement. It is recommended to install in the middle of the dip-rise gallery as well as in the middle of the split gallery for the pillar under consideration of split and fender method. It shall also be installed in the middle of the level gallery for the pillar under consideration of fish bone method. If the dilation is in between 5 mm to 10 mm then extra care has to be taken.

**5.3 Auto Warning Tele Tales.**

Auto warning telltale (AWTT) is basically a single point telltale instruments. It gives the information of relative movement among two strata at different horizon. It is proposed to fix one end at 15.0 m above the roof level. It gives signal after crossing the set limit of roof movement. It is suggested to install the auto warning telltale at all the three-way junction in the split – fender and four-way junctions (original and at the junctions formed due to taking the two way slices in the fish –bone method).

**5.4 Stress meters**

Vibrating wire type stress meter is used to measure the induced stress value. It is proposed to be installed in the pillars to monitor the vertical induced stress value during

depillars operation. It should be installed into the boreholes horizontally drilled into the pillars.

**5.5 Four Way Roof Extensometer.**

This instrument used for monitor of the separation in the layers of the roof during depillaring operations. These instruments were installed in upward holes. The anchors have to be fixed at 1.5 m, 5 m, 10 m and 16 m from the roof horizons. Total four numbers of four-way roof extensometers are proposed to be installed at the junctions

After successful working of caving panels by using CM Technology, the performance of the mine has improved. The OMS in the CM panel is varying from 4 to 5.

**VI. PERFORMANCE OF M/S SINGARENI COLLIERIES COMPANY LIMITED(SCCL):**

The coal producing performance of SCCL from the last 10years shown in the Fig no.2 achieved almost 100 % targeted production from both the UG & Opencast mines.

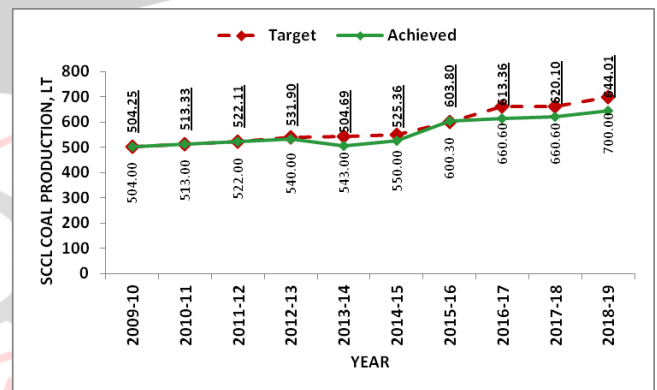


Fig no.2 Last 10years Coal producing trend from M/s Singareni Collieries Company Limited.

Fig no.3 showing the performance of UG mines in SCCL achieved coal production an average of 73% of targeted coal production from the last 10years from the highly mechanized mines, mechanized mines and semi mechanized mines of SCCL.

CM Technology is a machine and it is used in a mechanized UG coal mines to retreat faster rate of extraction than other conventional & semi mechanized method of extraction with high productivity achieved in the GDK-11 Incline mine maximum 7.8.

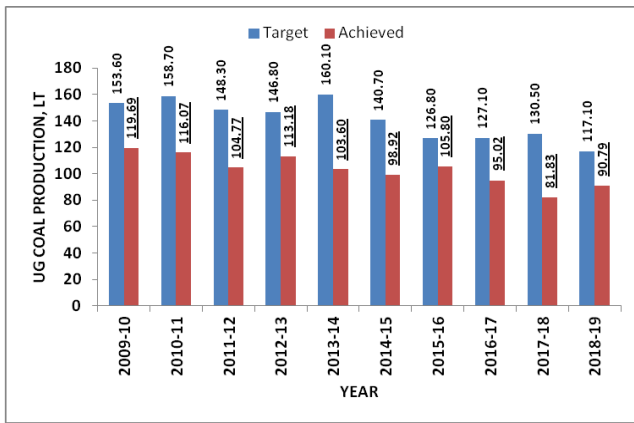


Fig no.3 Last 10years coal production from the UG mines of SCCL

Highly mechanized mines and mechanized mines were achieved 100% production among all the UG mines of SCCL, i.e. from High capacity longwall and CM technology mines.

Where the CM technology introduced and working successfully in one of the old mines which is having extensive developed pillars in the mine, achieved the maximum production of around 119% with the average achieved production upto 100% for the last 5 years shown in fig.4



Fig no.4 Annual Production trend of CM technology at GDK-11Inc, Ramagundam Area-1 for the last 6years.

For every CM technology working with the help of ancillary equipments to boost up the production with safety and this technology consists of the following equipments:

- a) Continuous Miner : 1 No.
- b) Ram Cars : 2 Nos.
- c) Roof Bolters : 2 Nos
- d) FBL loader/MUV : 1 No.
- e) Feeder Breaker : 1 No.
- f) Load Center : 1 No.
- g) Hydraulic retriever : 1 No.
- h) Auxiliary fans : 2 Nos
- i) Belt conveyors : 1 No.

## VII. CONCLUSIONS AND RECOMMENDATIONS:

- i) While striving for a sustainable development, mining industry is a major challenge in the world and it shall provide the employees with a safe and healthy working environment.
- ii) Mass production attaining with the CM technology by caving, and it varies from 1000 – 1500T per day.
- iii) CM technology is being introduced in new mines after touching the coal seam playing vital role in mass coal production from UG mines.
- iv) This CM technology avoids face drilling and blasting completely.
- v) For successful completion of the caving panel; instrumentation, RMR of the roof and size of the panel playing key role during coal extraction.
- vi) Every CM panel must modeling by software with the available data and fore cast the problems during extraction of coal from the panel.
- vii) The CM technology working/utilizing hours depends on the ancillary equipments(like roof bolters, shuttle cars or ram cars, feeder breaker, belt conveyors etc) and thus, presently the availability/utilizing hours of CM are about 79 % (standard-75%)
- viii) To increase rapid coal production, the utilization hours of the CM & its ancillary machines maintained in good working condition
- ix) Coal production increased in the CM panel with the hot seat exchange of operators of CM and its ancillary equipments.
- x) In the CM panel highest productivity may be possible with the designing of suitable layout of the CM panel

## VIII. ACKNOWLEDGEMENTS

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