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Adriyala longwall project – a breakthrough in hibernating period of Indian longwall mining

India's proclivity with mechanized longwall started in Moonidih Colliery in 1978. Subsequently 33 longwall faces were introduced with overseas collaboration. The longwall production peaked up to 2.3 Mt in the year 1996-97. But later it went a steep decline and by 2008 with only three or four longwalls were in operation. Then after the longwall technology went through a hibernating phase with only two operating longwalls were in 2013. The reasons for this down trend are the selection of under rated powered roof supports, strata management issues, spares management issues, lack of indigenous manufacturing facilities and less than adequate trained man power etc. [1,2]. The need to curb this undesirable trend was recognized by Singareni Collieries Company Limited (SCCL), India making attempt to introduce a high capacity longwall, gave Adriyala longwall project. The impetus for the construction of high-end longwall was to increase the share of underground coal production and to explore the deeper deposits with high productivity.

This paper explores the construction, ongoing operations and the challenges faced at India's highest capacity longwall project. A brief review on various aspects in constructing the project right from the exploration stage to outbye belt laying and panel preparation is given followed by the operations in I and II longwall panels.

1. Introduction

Adriyala longwall project (ALP) is one of the mechanized underground mines operating in the Ramagundam coal belt, SCCL in Godavari Valley Coalfields (GVCF), Telangana state, India. There are four workable seams in the mine with little geological disturbance. The extractable reserves in the project area are 78.597 million tonnes (Mt). The rated production from the project is 2.817Mt per annum and has a planned life of 35 years. The mine is accessed by four punch entries located in the No.1 seam from the adjacent Opencast-2 mine highwall and one return air shaft of 7.5m diameter sunk up to 484m depth from the surface.

Trunk and gate roads of panel I and II were developed with twin bolter-mounted LH-1400 roadheaders, panel III gate roads are being driven by bolter miner in place of road headers and other galleries with drilling and blasting and coal hauling and dumping on belt conveyor with two side dump loaders and two load haul dumpers. LWPs with lengths in the order of 2.0km and a face width of 250m are worked with state-of-the-art face equipment.

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The longwall equipment consists of EL 3000 shearer with 2245kW installed capacity, armoured face conveyor (AFC) with installed capacity of 2565kW, beam stage loader (BSL) of 400kW, 146 shields of capacity 2×1150t and 1.75m width, 2×4.5MW of 11kV/3.3kV transwitches and 3 Km long, 1600mm wide gate belt with 3×315 kW drives.

The following new technologies have been introduced at the project for the first time in India:

- Punch entry (direct access to coal from opencast highwall)
- 11 kV power transmission to UG (for less voltage drop)
- Pre-tensioned cable bolting (for effective roof support)
- Automation systems (for sequence control/less manual intervention)
- 400 kW high capacity fan (to supply more air with high water gauge)
- Diesel transport vehicles (FBL) (for flexible, speedy and safe equipment transportation)
- Floor concreting in underground (for diesel vehicle movement with heavy equipment)
- VFD controlled un-manned belt conveyor system (for soft starts and power conservation)
- Mine cruiser (for faster and safe transport of men)
- Air chilling plant (To create comfortable environment conditions)
- Rapid face bolter (for faster rate of supporting during salvage)
- Bolter miner (for faster rate of roadway development)

2. Construction of high capacity longwall

2.1 Exploration

A total of 95 boreholes have been drilled with the density of about 25 boreholes per sq.km for delineation of Adriyala longwall block. Coring was done in 19 boreholes and quality of the coal seams was obtained from 61 boreholes. Geo-engineering data is generated from 12 boreholes and Geo-physical logging was carried out in 44 boreholes using analogue model series-III logging system Mount Sopris Instruments Ltd, USA and digital logging system of Robertson Geo logging of UK.

The following are the studies done:

- Core photographs and Core profiler software.
- Micro logging of core samples.
- Minex modelling.
- In-situ stress and permeability studies by hydro fracturing method.
- Generation of physico-mechanical properties (PMP) data.
- Underground geotechnical mapping.
- In-situ strength of coal samples.
- Geophysical logging.
- Preparation of geological/geotechnical hazard map.
- Statistical analysis of PMP data.
- Caving behaviour of roof strata.
- Piezometric studies

Additional works and advanced studies done as suggested by CSIRO, Australia.

- Increasing borehole density to 25 BHs/sq.km.
- Geo-physical logging in more number of boreholes and some advanced geo-tech studies and interpretation methods.
- Cross checking of geo-technical data by other agencies such as NIRM, CIMFR and CSIRO.

Advance strata monitoring in working longwall face of GDK-10A to interpret those data to Adriyala longwall.

2.2 Punch entries

The unique feature of the project is that the main entries are planned through the adjacent rise side opencast mine. A platform of about 200m×150m is prepared adjacent to highwall at No.1 seam floor (120m depth from surface). The highwall was dressed at proposed locations of punch entries in No.1 seam then RCC blocks of 5.5m×3.6m × 1m dimensions were spread on the floor from highwall for a length of 15m. The gap between highwall and blocks was covered to prevent fall of loose boulders from highwall. The highwall was stabilized with cable bolting and cement injection along the periphery of the proposed punch entry. Then four punch entries of size 5.50m×3.60m were driven in top section of No.1 seam for a length of 1.80km at 1 in 5 gradient using roadheaders, as shown in Fig.1(a) and (b). Initially, goal post supporting was done for 20m distance from entry of drivage in addition to roof bolting. These are the main entries for the project and planned for man riding system, trunk belts, diesel vehicles roadway and haulage system one in each punch entry.

2.3 Mine development

The drivage of trunk roadways (5.50m × 3.60m) and gate road ways (5.20m × 3.60m) was made using twin bolters mounted roadheaders (DOSCO, LH 1400 model). 25km of drivage was made during 2011 to 2016 (5 years) using 05 no's of road headers. Now for panel III gate roadways, bolter miner is commissioned. The gate roadways are supported with 2.4m, Ø22mm shear pin bolts with full column resin grout and rigid wire mesh. Secondary supporting was done in gate roadways with 6.1m long pre-tensioned cable bolts to bear the abutments ahead of longwall. The installation face widened to 8 m was successfully supported twice in the two panels by adopting pre-tensioned cable bolts, without erecting vertical support. The details of underground workings are shown in Fig.2.

2.4 Shaft sinking

At Adriyala shaft project, sinking and lining of a return air shaft of finished diameter of 7.50m and depth of 468m, with necessary insets was done. The shaft sinking arrangements are as shown in Fig.3 (a) and (b).

Fig.1(a) and (b) Punch entries layout and one of the punch entries

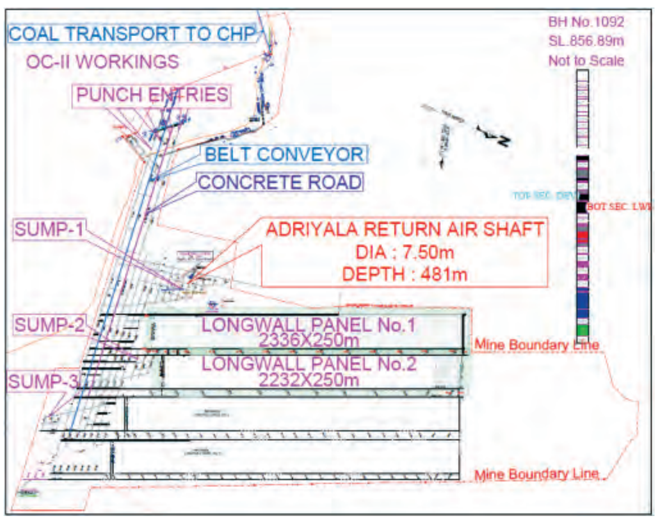

Fig.2 Plan showing the underground workings of ALP

Fig.3(a) and (b) shaft sinking arrangements

Lining was done with reinforced cement concreting of 300mm thick M-20 grade, containing coarse aggregate of 20mm down gauge of approved quality (in conformity with IS: 456-1978). While sinking return air shaft, challenges due to unconsolidated strata, running sand, shale and clay layers at several horizons were encountered. Water seepage was more than 600GPM. To counter the above problems the following were done.

- Reinforcement of surface strata with concrete injection up to a depth of 30m.
- Drilling of boreholes from the existing shaft bottom to 60 level gallery (underground working) for draining out the seepage water from the shaft/progressive shaft bottom.

2.5 Ventilation

Adriyala project is planned to work in the depth range of 300m to 640m. The geothermic gradient is about 69°C. To meet the ventilation requirements, a study was done by ISM, Dhanbad and according to the requirement mine drivages were developed. Adriyala mine is accessed by four punch entries and one shaft. Two main fans of 400kW and 15,000 cu.m/min and four booster fans of 75kW of 4,000 cu.m/min capacities were procured from Zitron, Spain and installed. Fig.4 shows the view of main fan.

Initially, when longwall panel started wet bulb temperature was about 28°C. But after working for 450m retreat, the face wet bulb temperature gradually increased to 32°C due to heat generation from working machinery, large goaf area, hot strata water (35°C) flowing along the bottom gate roadways and large volumes of coal cutting in the face.

Fig.4 Main mechanical ventilator

The following measures were taken to improve environmental conditions at face:

- All pumping stations, belt roadway and all drives were given separate ventilation splits to eliminate addition of heat to longwall intake air.
- Small 12 tonnes capacity air conditioners were provided to supply cool air to critical electrical i.e., face load centre and pump load centre.
- 20hp fans were installed with ducting to supply fresh intake air to all important electrical controls.
- One Ø8" pipe line was laid in TG-2 roadway for carrying all the goaf water directly to sump.
- All the water is diverted to covered drains/pipelines to reduce humidity.

2.6 Outbye conveyor system

Conveyor system of 9 km long from longwall gate belt (underground) to Coal Screening Plant (CSP) is installed and commissioned with 11 conveyor belts with installed capacity of about 12 MW. Huge civil foundations were prepared, some of which were on dumped over burden (OB). To prepare the civil foundations on overburden dumps, dumps were excavated up to 10m deep and then filled and compacted layer by layer with suitable material up to required level. Then required excavations and civil foundations were made in the compacted zone as shown in Fig.5. The conveyor system consists of nine steel core belts and 02 PVC belts of 1600mm width, 3500TPH capacity, 4.0m/s speed and variable frequency drives (VFDs) as shown in Fig.6.

2.7 Training

No. of teams consisting of officers, supervisors and technicians were trained in Germany, Australia and China on Longwall mechanization and diesel vehicles. Further training was given to Adriyala team in Mini build on surface for 3 months and also training on 11 kV equipment was given by Victor, UK. In view of the large underground mine and many new technologies have been adopted in the project, a training centre was provided specially for Adriyala to give initial and refresher training to the longwall employees.

2.8 Power supply system

11 kV transmission system was introduced in Indian underground coal mine for the first time. A total of 7.5 km overhead lines and 19 km of cable is laid to meet the huge power requirements. Auto power factor correction unit was installed for the first time to curtail the wasteful energy loss. The total connected load of the project was 24MW and increased to 30MW with the addition of air chilling, nitrogen and compressor plants.

Fig.5 Civil foundation works

Fig.6 High capacity belt conveyor system

2.9 Floor concreting

To facilitate transport of longwall equipment using diesel vehicles, one of the trunk roadways with weak floor was concreted with M-40 grade self-compacting concrete for a length of about 2.0km. Longwall panel top gate was also concreted for about 200m length near coal floor from trunk roadway to reach of stone floor in bottom section. In gate roadways, stone floor is strong enough to take load of heavy longwall equipment.

Batching plant was installed on surface; from there concrete transported to punch entry mouth by mobile mixer and then concrete trolley with mixer is taken to bottom most point of the roadway with the help of direct hauler and floor mounted track. Concreting started from dip most point and proceeded to rise side. Before concreting, the solid floor is exposed and the bigger depressions are filled with sand before putting concrete on the floor. 2.0km concreting pavement at not more than 1 in 4 gradient @ 1m/day. The surface of concreted roadway is provided with deep grooves to provide grip to the rubber tyred diesel vehicles. Cross drain of 2" groove along road width is provided at every 200m interval along the concreted roadway as shown in Fig.7 (a) and (b).

2.10 Transport and installation of longwall equipment using diesel vehicles

Diesel driven free steered vehicles are deployed for material and longwall equipment transport. The longwall equipment weighing about 35-50 tonnes were transported at 1 in 4 gradient on the concreted roadway successfully. Total equipment transportation from surface to longwall face and installation was done using diesel vehicles supplied by Caterpillar - Australia.

Risk assessment was done and safe operating procedures were prepared and implemented for transport of heavy equipment. Vehicle is subjected to braking efficiency on test ramp of 1 in 4 gradient on surface before sending any diesel vehicle with heavy load below ground. Approx. 9000T of equipment was transported by SH660D (50T), CL-210 (10T), CL-215 (15T) and SH-150 (35T) vehicles. Fig 8 (a) and (b) shows the break-testing on ramp and transportation of PRS with diesel vehicle.

3. Operational aspects of Adriyala longwall project

3.1 Longwall face operations

Face cutting operation

The basic cutting sequences in longwall are Bi-Directional (Bi-Di), Uni-Directional (Uni-Di). At Adriyala face cutting is being done in Uni Di method. The Uni Di method is a simpler

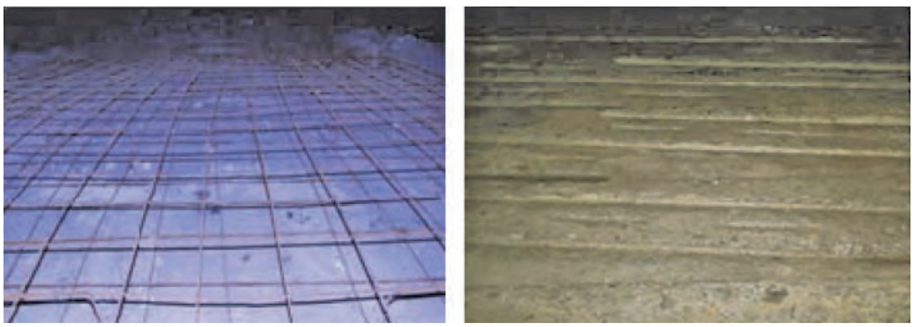

Fig.7(a) and (b) Concrete roadway for movement of diesel vehicles

Fig.8(a) and (b) Brake testing on RAMP & Transportation of PRS with diesel vehicle system to operate, enables operators to keep away from high dust concentrations, can allow the loading onto the coal haulage system to be made more even and can at times equal or even exceed Bi-Di production. In the event of roof cavities and poor strata conditions and to move creep upward Bi Di cutting method is being followed at Adriyala.

Creep control, face alignment and horizon control

These three are very important parameters in successful operation of longwall, to be monitored continuously and to be maintained within the acceptable levels. The creep is stabilised by maintaining the staggering of about 20-25m (keeping the bottom gate 20-25m ahead of tail gate) between two gate roadways. The face is kept at an obliquity of 4 degrees (half of the seam inclination) from perpendicular. Face alignment and horizon control play a key role in mitigating the strata control issues and in increasing the life of face equipment. The proper face alignment and horizon control are ensured in every shift physically and every alternative day face offsets and heights are taken and plotted by surveyor and shown to panel incharge. Very strict operational discipline is required to maintain the above parameters within the acceptable levels.

Automation and SCADA (supervisory control and data acquisition)

Leg pressure in PRS (powered roof support) system, face straightness, concentration of operating fluid are monitored, recorded and displayed, concentration of operating fluid for the PRS system is monitored at the power pack by automatically measuring the quantities of water and concentrated emulsion added in the mixer to determine the concentration of the emulsion added to the tank. Total quantities added over time are also recorded to indicate total fluid usage/leakage. Shearer initiated roof support advance (SIRSA) with batch control and auto horizon control are provided. Shearer condition and location is monitored, displayed and recorded.

Automation system includes monitoring and visualizing the installed shearer sensors such as voltage, motor temperature, ranging arm oil temperature, power pack oil temperature, traction oil temperature, power pack oil level, cooling water pressure, cooling water flow, drum pressure, drum water flow, machine mode, state automation, face along angle, face advance angle, cutter current, pump current, haulage current, coal sizer current, transformer current, position, arm height and speed of the shearer.

AFC tensioning is monitored by electric tensioning device at tail gate, displayed and recorded, snaking control is done by definition of snaking area and web width. These will be controlled and monitored, displayed and recorded, amperage and voltage are controlled by electrical energy train and will be monitored, displayed and recorded at the energy train and diagnostic information/condition monitoring for shearer, PRS (with sensors for leg pressure, stroke advancing ram cylinder, stroke of flipper cylinder. Based on these sensors values shield position, conveyor position and convergence monitoring (pressure dP/dT) can be calculated and monitored), AFC (with sensors for motor current, gearbox: coupling pressure, cooling oil pressure, temperature 2x, difference pressure filter, input speed, output speed, oil level and system pressure) can be monitored by automation system. The power pack and BSL is monitored by the electrical installation (via SCADA). All information shall be monitored, displayed and recorded. Convergences is measured by PRS system, displayed and recorded. Convergence measurements are done by measurement of the change of shield leg pressure as a dP/dT value and visualized by Caterpillar Automation. The entire latest configurations of online monitoring are provided.

3.2 Water management

Periodical falls of overlying strata are taking place in the goaf with retreat of longwall face. During each periodic fall, the overlying strata breaks and disturb overlying water bearing strata in turn water flowing into goaf through the cracks. The water coming from goaf will increase with each roof fall. It is expected that about 1000GPM of water will be flowing from the goaf by the end of panel.

About 700GPM water from longwall goaf, flows through bottom gate and immediate outbye cut through and from there through the cleaning chambers in to 08" pipeline laid in TG 2 and directly delivered in to SUMP 2 by gravity which has a capacity of 27 lakh gallons.

3.3 Subsidence

Subsidence pillars were constructed at 30m grid pattern to study the subsidence over LWP No1. The LWP No.1 was started on 15.10.2014 and till now about 1500m retreat was completed. Over longwall panel up to 1100m distance an external OB dump was there (from 0 to 500m it is 60m height and 500 to 1100m it is 45m height). The main fall occurred after retreat of 83m in the month of December 2014, but the first subsidence was noticed in the month of April 2015 and progress was 400m. Hence the first subsidence was noticed after progress of about 350m to 400m. First 150m from the face start line, there was no subsidence due to barrier effect and subsidence further occurring regularly.

The subsidence trough have a maximum vertical movement of about 1400mm on original ground and 1900mm over the OB dumps within the panel with the maximum subsidence point shifted at about 50m towards the dip side from the panel centre. Cracks of width 5mm to 20mm were observed at the dip side of the panel.

However distinct cracks attributing to subsidence could not be clearly seen on the rise of the panel. The cluster of tensile cracks can be seen mostly over the dip side panel boundary and over the panel barrier.

3.4 Strata control management during development and longwall retreat

Gate roadways

Initially roof disturbances were observed and on two occasions cavities occurred in gate roadways driven in bottom section taking middle clay into working section. Later geological mapping and lithological study was done and working section has been changed by leaving middle clay in the overlying strata with 1m coal underneath it, which improved the stability of gate roadways.

Cut throughs

The cut throughs were driven in between two gate roadways (MG1&TG2, MG2&TG3) at 200m interval. Initially cut throughs were driven across the major horizontal stress direction, in which severe strata control problems were encountered and cavities also taken place. Later the direction of cut throughs have been changed and aligned with major horizontal stress direction which eliminated all strata problems. Initially gate roadways were supported with roof bolting with linked wire mesh in the roof. Later rigid wire mesh has been introduced in place of linked wire mesh to reduce supporting cycle time and to improve the supporting efficiency of the system. The roof conditions and drivage rates have been improved with introduction of rigid wire mesh.

Face dip widening

Strata problems were encountered while widening longwall installation face with 8m width. As per the recommendation of geo-tech consultant, pre-tensioned cable bolting (6.1m) was introduced for the first time for better strata control and to eliminate vertical support in face dip to facilitate the movement of diesel vehicles. After supporting with cable bolts, the face dip was widened to 8m without any strata control problems.

Gate roads monitoring

Tell tales were installed for every 50m interval to monitor the bed separation at two horizons and convergence stations were installed for every 25m interval to monitor the convergence in gate roadways.

Main and periodic weightings in longwall face

Regular falls are taking place in the longwall goaf without any strata problems in the face. First local fall occurred after retreat of 44m and main fall occurred after retreat of 83m (22,000sq.m). Subsequently periodical falls are taking place at an interval of 16 to18m. During weightings, mid zone supports (about100-120 out of 146 supports) attaining yield pressure of 450 bar and pressures are being released after completion of 5/6 mining cycles. Breaker line is formed parallel to face and about 1m ahead of the face and water seepage is observed with negligible face convergence during every weighting [2].

Surface borehole extensometer

To study the caving behaviour of the LWP No.1 above No.1 seam of ALP, surface multipoint borehole extensometer was installed at 1130m location from the longwall installation face which located at the middle of the face (equal distance from the main gate and tail gate). The installation was completed in the month of June 2015, when face was about 500m away.

Two anchors were installed at two horizons. One anchor is located at 275m depth from the surface (i.e 125m above the No.1 seam roof) and second anchor is located at 230m depth from the surface (i.e 170m above the No1 seam roof). The first bed separation of 40mm was noticed on 02-01- 2016 when the face crossed by 60m. The total bed separation from surface to 230m is 210mm and from 230m to 275m is 90mm and the total cumulative bed separation was about 300mm when the face was 260m outbye side, after that the beds were stabilized and no further movement was noticed. The subsidence at that location was about 0.9m.

From the above, it is clear that the overlying strata is falling at regular intervals and filling the void. The strata movement is active between 60m-260m behind the face.

3.5 Goaf inertization

Nitrogen flushing: CSIRO, Australia has recommended to install Nitrogen Plant to carry out longwall goaf inertization continuously as a proactive measure to prevent spontaneous combustion in LW goaf. Accordingly N_2 plant was installed with a capacity of 800 Cu.m/hr and N2 flushing is being done. To increase the rate of flushing, a new Nitrogen plant of 1200 Cu.m/hr capacity was commissioned in October, 2016. In addition to N_2 flushing, CO_2 is also being flushed at the rate of 3 tonnes/day into the goaf.

3.6 Air chilling plant

To provide cool ventilating air to the workings it was proposed to install air conditioning system at ALP. A study was carried out by IIT (ISM), Dhanbad for the design of air cooling system. The procurement of above chilling plant was delayed due to some technical reasons. Meanwhile, to meet immediate requirement of longwall face (panel 1), outsourced air chilling plant of 1400TR was installed at mouth of punch entry-5 (PE-5) as shown in Fig.9 (a) and (b). About 3500cu.m/min of chilled air is being supplied at 11 to 13ºC at the entry of PE-5. From there cooled air is ventilated to longwall face through a separate air way via PE-5 and Main Gate-1. After commissioning of air chilling plant and supply of cool air, the temperature has been brought down by 3 to 4ºC. Efficiency and effectiveness of men and machinery increased considerably.

In panel 2, as the distance was increased further the supplied temperature at the entry of PE-5 is decreased to 9ºC and to save the energy water cooled chillers are being used instead of air cooled chillers used in panel 1.

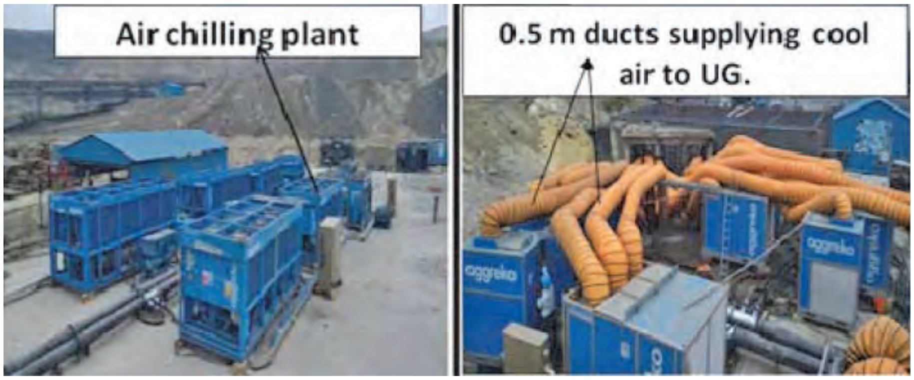

Fig.9(a) and (b) Layout of air chilling units and ducting arrangement

Fig.10 Mine cruiser for men transport

3.7 Transport of men with diesel mine cruisers

Three chair lift systems covering a distance of about 3.25km from RAMP to entrance of the gate roads. For the purpose of longwall and roadheader production crew a diesel mine cruiser (Fig.10) of Bird Machines, South Africa supplied by Bharat Earth Movers Limited (BEML), India is provided first of its kind in Indian coal industry which enables to transport men faster to the face. The diesel mine cruiser can carry 16 persons and can negotiate a maximum gradient of 1 in 4. After successful trials five more machines will be deployed.

3.8 Rapid face bolter

Rapid face bolter has been introduced at Adriyala for the first time for supporting the roof during the meshing operation at faster rate in panel I. This avoids the usage of hand held drill machines in the face which resulted in improved safety of the workman provides an increased safety and operator comfort on actuated platforms, capable extended towards the face. With two independently controlled drill rigs it provides optimum efficiency for bolting operations as shown in the Fig.11. Extendable operator platforms and raised extension platforms provide a flexible and safe operator environment.

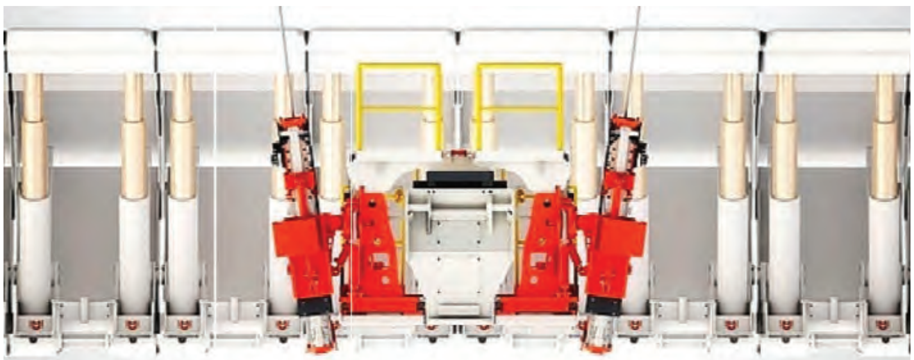

Fig.11 Rapid face bolter

3.9 Performance

The first longwall panel was commissioned on 15.10.2014 with a rated capacity of 2.5 MTPA. The length of the face is 250m and the panel length is 2333m, with reserves of about 3.36Mt. Adriyala records a monthly highest production in April 2016 with an output of 2.53LT and daily highest production of 13,187 tonnes on 29.02.2016. Initially, the performance was not satisfactory due to failure of variable frequency drives (VFD) and loop take up winch hydraulic motors on gate belt and few components in face load centre electricals. Gradually the production got stabilised and panel 1 extraction was completed by producing about 8000-9000tpd.

Presently, extraction of the second panel is under progress and about 4.50LT of coal has been produced at a rate of 7000-8000tpd.

4. Observations

Initially, the project operations were interrupted by opencast activities like blasting and movement of heavy machinery movement. Later, the OC workings progressed well away from punch entries and there was no interference.

- Once an abnormal flow of water of about 1200 GPM was observed against the normal flow of 600-700 GPM from the goaf. It was not a surprise as surges were observed in the earlier longwalls of adjacent mine. Installed the pumping capacity with a factor of safety of 2 to take care of surges.
- It was envisaged to introduce air chilling plant but order could not be placed due to technical reasons. During the

working of longwall panel, the face temperatures gradually increased to 32ºC to 33ºC with 100% humidity at support no.1 and became difficult for workmen to work throughout the shift. The increase in the temperature mainly due to hot strata water at 35 degrees flowing along bottom gate roadways against the incoming air, some of the air is entering into goaf at main gate and joining the face from middle of the face to TG with increased temperature and humidity, heat released by freshly cut coal and electricals and longwall machinery. Immediately suppliers of chilling plants were explored and found Aggreko (Pune), who supply surface chilling plants on rental basis. Order is placed and plant was installed on surface in the month of November, 2015.

- The use of diesel vehicles, eliminated the following during installation of longwall face:
  - Loading and unloading stations at face.
  - Marching of shields in the face and anchoring of dowels in the floor for marching.
  - Reduced cycle time for installation of shields and other equipment as the transport was done up to the installation point and lifting, dragging and adjustments were done with diesel vehicles. Transport of mine material and equipment with diesel vehicles has become a way of life.

5. Recommendations

The experience of first high capacity longwall face at Adriyala longwall project, SCCL is encouraging. Basing on this the following can be taken up:

- Planning bigger panels as in Adriyala where ever clean property is available
- Increasing the extraction height to about 5.0m wherever seam thickness permits. In such case, sufficient reserves will be available to introduce
- Planning longwall top coal caving (LTCC) for thick seams up to 10-12 m. with reduced panel dimensions (No.3 seam). The geology will permit to plan such longwalls in most of the places in SCCL and CIL.
- Longwalls with an annual capacity of 1.5-3.0Mt with panel dimensions of 1.0-1.5 km × 150m.

Air chilling plants are essential for working beyond 400m depth. The indigenous suppliers of air chilling plant are not available and need to be developed in India.

Though man riding systems like chair car and chair lift systems are provided in trunk roadways, it is required to provide diesel cruisers for transport of men. Men transport with diesel cruisers is very flexible and reach every point in the mine in minimum time. Particularly longwall crew and development crew need to be transported by mine cruisers to minimize travelling time.

Proper water management is essential for successful operation of longwall. The mine sumps are to be designed with sufficient storage capacity (at least two days capacity) and cleaning arrangements, sufficient dip side development to take care of water surges from longwall and adequate installed pumping capacity. Cleaning chambers along the gate roadways and slurry pumps are to be provided.

All categories of workmen including officers are reluctant to work in underground in general and longwall in particular due to arduous working conditions and long working hours compared to opencast mining. Hence it is required to motivate longwall team to work voluntarily.

6. Conclusion

Longwall mining is done successfully in all major coal producing countries even in difficult conditions like highly gassy, hard roof and steeply inclined seams. It is proved beyond doubt that longwall as an underground mining method is successful in India as it was introduced with proper spirit. The suitable underground geological blocks need to be identified for introduction of high capacity longwalls on large scale with the help of global operators. CIL, SCCL and private operators who are allotted coal blocks for underground coal mining must plan to introduce as many longwall faces as possible and LTCC for thick seams in the blocks which are feasible for bulk production.

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