B. BHASKARA RAO
and
B. VEERA REDDY

Planning a high capacity longwall project in SCCL vis-à-vis challenges encountered – a saga of the Adriyala longwall project

Introduction

Coal shall remain one of the key growth drivers for India for at least a few decades to come, inspite of the global concerns against the use of fossil fuels as it is the prime source of the country's energy needs. During the past few decades, the opencast mining has attained dominant share of coal production as it is economical and productive. But increasing striping ratios, constraints in land acquisitions etc. will make opencast mining give its way again to underground mining at least partially. The longwall technology is the most proven underground method of extraction of coal for bulk and economic production. It is essential that the method makes its due share in meeting Indian coal demand. For bulk production of coal at faster rate from underground coal mining particularly at depths the only proven technology world over is longwall mining.

India had its first mechanized longwall face in 1978 at Moonidih Colliery. Subsequently 33 longwall faces, including 10 longwall packages from Singareni Collieries Company Ltd., (SCCL) are introduced with overseas collabaration. The longwall production peaked up to 2.3 million tonnes (Mt) in the year 1996-97. But later it went a steep decline and by 2008 except GDK 10 in SCCL and one or two in Coal India Ltd., (CIL) no other longwall face is operative in India. The major reasons for this decline are attributable to under rated powered roof supports, strata management issues, spares management issues, lack of indigenous manufacturing facilities and lack of adequate trained man power etc. The need to curb this undesirable trend is recognized by everyone; Adriyala longwall project remain the first major initiative realized this dream after a long gap. This paper shares the process went into making this dream true.

1.0 Genesis and evolution of longwall technology

The seventeenth century innovation of 'Longwall' (LW) system in Shropshire in England has made giant strides over the past three centuries to emerge as the predominant bulk production system in global coal industry today with a share of nearly 70% of aggregate production and is recognized as the safest, the most productive and cost-effective method as well as for extraction of coal seams by underground mining.

Messrs. B. Bhaskara Rao, Director (Planning & Projects), dpp@scclmines.com and B. Veera Reddy, General Manager, Adriyala Projects Area, gm_adriyala@scclmines.com, SCCL

In India first mechanized powered roof support (PRS) face, the new-age longwall, was launched in August 1978 at Moonidih Colliery. In India, 33 Longwall packages have been deployed to date in CIL and SCCL in collaboration with U.K, Russia, China, France mostly funded by GoI. In the early 80's and 90's longwall technology was introduced in the mines of CIL as given in Table.1. During these three and half decades of longwall experience powered roof supports of capacity varying from 280 to 800 tonnes have been used at many mines in India under varying geo-mining conditions.

Majority of the longwall faces in India have been worked under relatively shallow cover (< 200m) and significant problems on the cavability of the roof have been experienced. The overall performance has fallen short of expectations despite the above experiences. Only a few of the faces could yield planned production level for initial three to four years of support life. A number of reasons have been attributed to the lower performance of such longwall operations. Severe strata control problems at face resulting in damage of supports and increased downtime of machinery substantiated by improper matching of the sub systems are understood to be two prime reasons for such poor performance. An unsuitable locale selection incompatible with the selected supports due to improper pre-investigation studies while planning worsened the situation in few cases.

TABLE 1: LIST OF LW INTRODUCED MINES OF CIL IN THE EARLY 80'S & 90'S

Year	Mine	LW sets
1978-85	Moonidih, BCCL	3 (MAMC, Gullik & Kopex)
1985	Seethalpur, Jharia	1
1982	Demomine, Ranigunj	1
1982	Pathakhera, Ranigunj	1
1990's	Churcha, SECL	1
1990's	Jhanjra	3 (Gullik Dobson, USSR)
1990's	Kottadih	1
1990's	Balrampur	1 (CME, China)
1990's	New Kumba	1 (CME, China)
1990's	Rajendra	1 (CME, China)

Table 2: List of powered roof supports (PRS) deployed at longwall faces, SCCL, India

Mine	Initial/ shifted	Date of commission	Make	Capacity of PRS	Rated TPD
GDK.7 incline	Initial	02-09-1983	Gullick Dobson, UK	4 × 325t to 4 × 360t	
GDK-11A incline					
Unit-I	Initial	01-04-1991	Gullick Dobson, UK	4 × 430t	
Unit-II	Initial	10-10-1991	MECO, UK	4 × 450t	
Unit-III	Initial	16-12-1992	Gullick Dobson, UK	4 × 450t	
VK-7 incline					
Unit-I	Initial	13-06-1985	Gullick Dobson, UK	4 × 360t	1600
Unit-II	From GDK-11A	13-07-1994	MECO, UK	4 × 450t	
PVK					
Unit-I	Initial	21-08-1995	CME, China	4 × 760t	2200
Unit-II	Initial	22-06-1996	CME, China	4 × 760t	2200
JK-5 incline	Initial	06-06-1990	Gullick Dobson, UK	4 × 450t	2000
GDK-9 incline					
Unit-I	From GDK-7	31-01-1986	Gullick Dobson, UK	4 × 360t	
Unit-II	Initial	05-02-1996	MECO, UK	4 × 750t to	
4 x 800t	1900				
Unit-III	From PVK Unit -I	21-08-1995	CME, China	4 × 760t	2200
GDK-10A incline	Initial	18-10-1994	MECO, UK	4 × 800t	2200

TPD: tonnes per day

2.0 Experience of longwall mining at SCCL

Longwall mining was introduced in SCCL for the first time in GDK-7 Incline in the year 1983 and after successful completion of two faces equipment was shifted to GDK-9 Incline in 1986, where the longwall face collapsed due to inadequacy of the support capacity. Two more longwall packages were introduced in VK-7 and JK-5 Inclines in 1985 and 1990 respectively. Thereafter three more longwall packages were introduced in GDK-11A during 1992-93. Capacity of powered roof supports in the above mines is of 4×360 tonnes (t) and 4×450t. Later higher rated supports one set each in GDK-10A, GDK-9 Inclines and two sets in PVK 5 Incline were introduced. The support capacity in the above mines is of 4×800t and 4×760t with a support density of 110 to 120 t/m^2 respectively.

Before the introduction of high capacity longwall project in Adriyala, 10 longwall packages have been introduced in seven mines with collaboration of foreign countries like UK, and China, details of which are as given in Table 2. Presently the old generation longwall units were surveyed off/not in working condition.

The faces at SCCL in GDK-7 and VK-7 Inclines did well in comparison with other faces, which experienced caving difficulties.

In early nineties with the introduction of higher rated supports the performance of longwalls improved to some extent. Barring the catastrophic failure of longwall faces of Churcha, Kottadih and Dhemomain of Coal India Ltd., faces at GDK-10A, PVK, JK-5 and VK-7 gave consistently good results. The production performance of longwall faces from SCCL and CIL is as shown in Fig.1. Production trend of longwall mining in India from the year 1983 to 2006 is given in Fig.2.

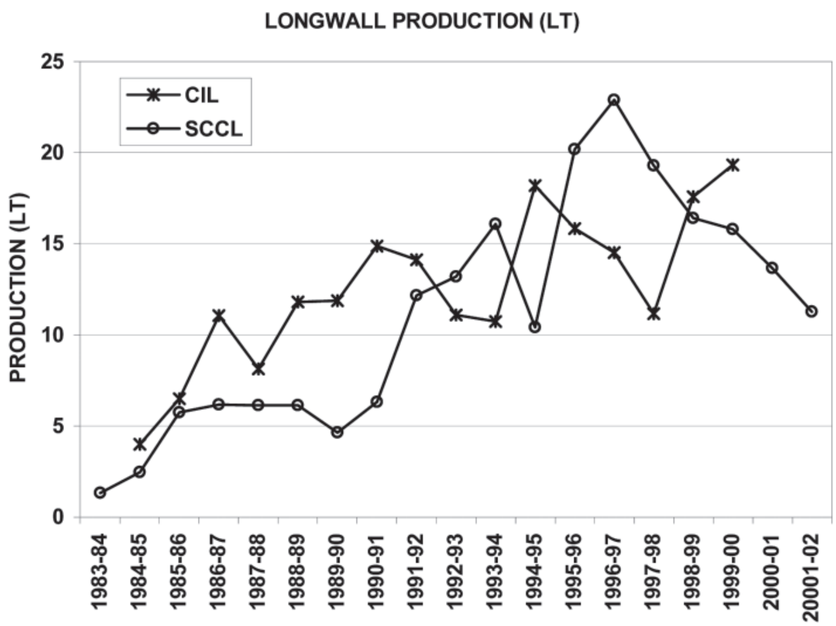

Fig.1 Longwall production in CIL and SCCL

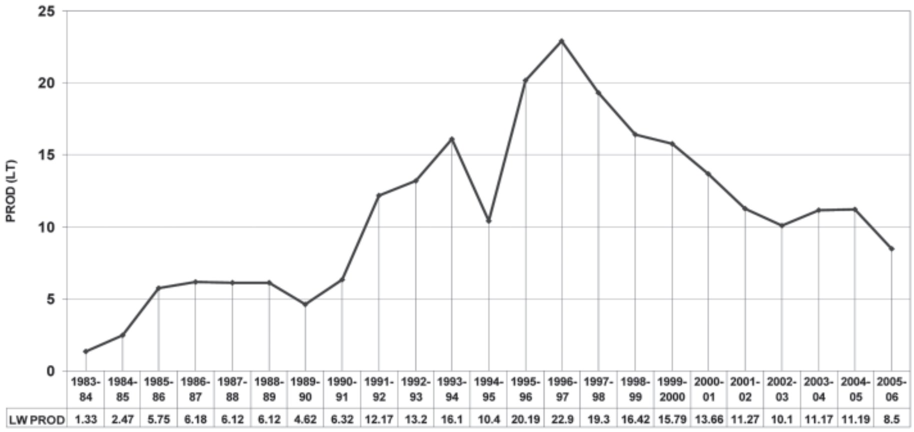

Fig.2 Production trend in LW mining in India (in LTPA): (1983-2006)

3.0 High capacity longwall project introduction in SCCL

As a part of the recent underground mechanization planning initiative, SCCL successfully commissioned a state of art high capacity longwall project at Adriyala longwall project introducing 2×1152 tonnes, 2 legged shield supports with a rated capacity of about 3.0 million tonnes per annum (MTPA).

3.1 Brief details of the high capacity longwall project

Adriyala longwall project is located in the southern and south western parts of ramagundam coal belt of Godavari Valley coalfield. The block is bounded by North Latitude: 18º 39' 03" - 18º 40' 34", East Longitude: 79º 34' 28" - 79º 35' 55" and covered in Survey of India Topo sheet No. 56 N/10. It is a linear patch trending in NW-SE over a length of 3.0 km. which broadly confirms with the generalized strike of bedding in the area.

The block boundaries are as follows:

South – Shaft block-III boundary

North – F2-F2, and Jallaram block boundary

East – Proved limit of III and IV seams.

West – GDK-10A incline boundary

Adriyala longwall project is a working underground mine of Ramagundam region with mechanized longwall technology with a mine take area of 964.12 ha. The proposed Adriyala longwall geological block area is more or less free from any major faults. The boundary faults in the property are (F1-F1 and F2-F2) exist in the Northern extremity.

3.2 Sequence of events in formulation of the Adriyala LW project

- The Project report was submitted to Ministry of Coal, GoI on 26.08.2003.
- Planning Commission accorded "In Principle Clearance" on 05.03.2004.
- The feasibility report of Adriyala longwall project of the SCCL was approved by the GoI vide letter No. 43011-23-2003-CPAM, on 29.09.2006. Adriyala longwall project was started in the year, 2008.
- Commonwealth Scientific and Industrial Research Organization (CSIRO) has visited SCCL and its proposed projects for high productive longwall projects.
- The Feasibility Report (FR) proposal of Adriyala was reviewed by CSIRO in-detail and they suggested some modifications initially.
- Consecutively, a team of Directors and Chairman and Managing Director had visited Australia and inspected various high productive longwall mines and longwall operation from an opencast mine through a special entries called 'Punch Entries' in 2005.
- Next to that various internal meetings were conducted.
- The technological changes had taken place around the world such as length of LW face, width of LW face, modernization of equipment, face automation were explained by consultants as suggestions during their visits and presentations.
- The success level of 150m manually operated LW faces were studied in-detail by CSIRO team.
- CSIRO team visited SCCL on regular basis and they brought other longwall consultants from Australian mining field to India for sharing of their experience.
- Considering several geological, mining and operational factors pertaining to SCCL, CSIRO has suggested further modifications in the FR proposal.
- In succession to the FR modification, CSIRO has suggested equipment specification too and they have in turn taken opinion of Andy Rutherford who is an expert consultant in Australia for longwalls.

3.3 Major modifications suggested by CSIRO:

- One high capacity longwall face instead of two sets low capacity longwall faces in Adriyala and Jallaram.
- Increasing panel lengths to more than 2 km length.
- Punch entries as mode of entry on southern side of the boundary to have longer panels which would be separate entries to the project with separate coal evacuation arrangements. (No intervention of activities of existing mines GDK-10A).
- Modification of equipment specifications.
- 1 set of higher capacity equipment for thick seams (1 seam, 3 seam, 4 seam) for both Adriyala and Jallaram.
- 1 set of low end equipment for thin seam (2 seam) of both Adriyala and Jallaram.
- Wider faces of 250m face width instead of 150m faces.

- The FR of Adriyala is provided provision for bolter miners for development. However, the equipment procurement could not be done in time for various techno, commercial and operational reasons. To avoid the delay in commissioning of the project roadheaders were introduced from other area and also purchased new roadheaders of Wirth and DOSCO make.
- Training in "Mechanised Longwall Mining" was arranged to SCCL personnel batch wise in China to cater the need for future longwall mining in the company.
- SCCL has appointed two more technical experts Mr. Russel Firth and Mr. Andy Rutherford with wide range of scope for assistance in implementation of the project.
- Based on their advice took different decisions on strata management and implementation and operational stages of the project.
- Build-Own and Operate (BOO) contract model of the project could not be realised due to unavailability of the contractor. In efficiency on the part of the contractor caused inordinate delay in implementation of the project.
- Consequently, revised cost estimates (RCE) were prepared based on the cost and time overrun of the projects for implementing the changes envisaged. Finally, 2nd RCE was approved in August 2014. Summary of major changes during the approval of project is given in Table 3.
- The project has achieved 0.60Mt in 4th quarter of 2015-16 against the quarterly rated target of 0.7025Mt which is 85.40%. As such the project has achieved its rated capacity by the end of 2015-16.
- Hence, the project has fulfilled its completion criteria as per the guidelines issued by the Ministry of Coal and the project is declared as completed by March-2016.

3.4 Geo-technical studies carried out in Adriyala LW block

SCCL identified a few blocks for high production longwall mining in collaboration with CSIRO; Australia. Adriyala is one of such projects located on the dip side of GDK-10A Incline. To enable planning and design of longwalls in Adriyala block, CSIRO suggested SCCL to generate detailed geo-technical data by conducting various studies, including drilling of additional boreholes.

During exploration, 95 boreholes were drilled at a spacing of about 25 boreholes per sq.km for the delineation of the Adriyala longwall block. Coring was done in 19 boreholes and coal quality data was obtained from 61 boreholes. Geo-technical data was generated from 12 boreholes and geophysical logging was performed in 44 boreholes.

Drilling of additional boreholes

Initially, 7 boreholes were proposed at 330m interval in panel-1 for referring coal and sandstone core samples for geo-technical lab studies, for preservation of core from one borehole for future reference and to conduct in-situ stress and permeability tests at 30 horizons in one borehole located in the centre of the panel in addition to lab tests. Altogether 19 boreholes were drilled as per the suggestions of CSIRO for both geo-technical and structure confirmation.

Extensive geo technical study

Generation of physico-mechanical properties (PMP) like – compressive strength, tensile strength, Young's modulus, Poisson's ratio, porosity, triaxial tests (cohesion and friction), direct shear and seismic velocity (P&S wave) tests from core samples, tested at CIMFR, Dhanbad.

In-situ stress measurements and permeability studies

The in-situ stress and permeability studies are required to

Table 3: Summary of major changes

Major items		Original FR-2006	RCE-2009	RCE-2012
Mode of entries	Shafts	2	1	1
	Trunks	Existing GDK-10A	Punch entries	Punch entries
Equipment proposed	Longwall	2	1	1
	CM/BM	1	2	
	RH	4		5
Panel dimension	Face length	150m	250m	250m
	Panel length	580 to 1265m	>2km	>2km
Rated capacity (MT)		2.144	2.81	2.817
Project life (years)		32	32	35
Reserves (LW only)		33.38	46.53	71.59
Electricity	Operating volts	1.1kV	3.3kV	3.3kV
	Supply volts	3.3kV	6.6kv	11kV
Mode of transport		Man winding shaft		Rail car + chair lift + FSVs
Coal evacuation		Overland conveyor from GDK-10A to RG OC-II belts		Overland conveyors from PE to OC-1 CHP

understand the magnitude and direction of the in situ stress field and permeability of the strata to enable mine planners to orient the LW panels. In panel-1, the depth of the topmost/ No. 1 seam varies from 360 m to 450 m. and bottom most/IV seam from 460 m to 550 m. The studies were conducted by Mesy (India) Pvt Ltd at the cost of 46.66 lakhs. In all the 3 boreholes, 17 in-situ stress measurements and 30 permeability tests were carried out at various horizons as suggested by CSIRO.

Extensive geophysical logging

All boreholes were covered with geophysical logging using multiple probes such as SPRN, density, neutron, caliper, full wave sonic, acoustic tele viewer with deviation (imaging) etc. The geophysical logging data helps in determining the geo-technical properties of inter burden strata of coal seams.

Hydro-geological investigations

Vibrating wire piezometers were installed in boreholes to monitor pore pressure and water level fluctuations, in addition to permeability studies through hydro-fracturing.

Preservation of core samples

One cored borehole (BHNo-1197) exclusively drilled for the preservation of cores for future reference, kept at project site.

Photographs of core samples

Core photographs of all cored boreholes were taken and preserved. Composite logs were prepared using the core profiler software.

In-situ strength of coal

NIRM conducted in-situ strength determination in I seam in GDK-10A Incline and in III seam in GDK-10 Incline. Coal specimens of 30 cm × 30 cm × 30 cm were prepared in the large pillars. The specimens were subjected to uniaxial loading using a high capacity hydraulic jack, and the deformation of the specimen was also recorded. Ratio of the load at failure to the surface area of loading gives the in-situ strength of the coal. The ratio of load to the amount of deformation indicates its stiffness.

Highwall scan mapping (punch entry area)

- The Siro Vision® system has been developed by CSIRO and is used to measure and analyse discontinuities in a rock mass.
- This system is based on a photogrammetric technique that allows 3D images to be constructed from 2D images captured with a digital camera.
- Structures can be mapped from these images quickly and safely, with no need to approach a potentially unstable highwall.
- The objective is to provide an analysis of the discontinuities present in the highwall of RG OC-II adjacent to the punch entries for the Adriyala project.

Roof hazard map

Rock mass behaviour, stress and mining conditions are going to be different at deeper depths. At deeper depth underground workings especially the longwall faces need to be designed on scientific studies. As part of this roof hazard maps are arrived based on geological/geo-technical and geophysical inputs.

Underground geo-technical mapping: The underground geo-technical mapping has been carried out at regular intervals in the gate roadways of Adriyala LW panels, as the drivage progresses.

3.5 Challenges overcome in the implementation of the project:

- SCCL, being a mid-sized company planned a mega longwall project of 2.817 Mt for the first time in the country, where there are no earlier bench marks within the domestic coal industry.
- Advanced planning: By the time the project got the initial approval, equipment specifications, design, consultancy studies and cost estimates should have been completed to the highest precision level.
- Statutory approvals: Despite having international approvals, imported equipment has to undergo domestic approval process. Deployment of one of the roadheaders (WIRTH make) was delayed by 20 months mainly on account of failure to obtain DGMS clearance by the supplier.
- Contractors' capabilities: Established agencies were not available as outsourcing of underground works started in SCCL in the recent past (2-3 years). Most of the outsourced works like floor concreting, roadway drivage with roadheaders and civil foundations works for conveyor drives were taken up in SCCL for the first time.
- Delays were due to shortage of skilled man power, works being taken up for first time in underground by contractors. In case of punch entries, global tendering could have been avoided the delay, however with an increased cost.
- Geo-tech issues in gate road ways:
  * Abnormal amount of convergence in the roof necessitating additional supporting.
  * First time in SCCL 2.4m shear pin roof bolts with resin capsules of fast and slow setting were used.
  * Roadway with 5.2m width and 3.6m height was driven and stone floor is partially cut to make it horizontal for movement of diesel vehicles.
  * It took some time to acquire reasonable expertise by the team during initial drivage.
  * Support systems and working section had to be modified frequently to achieve the desired level of strata control.

- Support testing: First prototype support was tested as per EN-1804-1/2 protocols at Dekra for 60,000 cycles and parent metal cracks were observed on components of support. Hence, SCCL insisted for redesign and retest, which resulted in 20 months of delay. SCCL has taken due care in formulation of stringent quality norms in Tender Notifications (NIT). Earlier, there was no such practice of witnessing the testing of prototype supports.
- Civil foundation works for outby belts and gantry works: Four drives were located within the loose over burden dumps of quarry area, requiring compaction up to 10m depth. During 2013 highest rainfall was recorded i.e., 1698 mm against the average annual rainfall of about 800mm. This resulted in delay in installation of outby belts by about one year.

3.6 First time undertakings

The following activities/parameters have been implemented for the first time in India/SCCL.

- Longwall project of 2.817 MTPA capacity
- Working beyond 400 m depth.
- 250 m face length and more than 2 km panel lengths
- Driving roadways of large dimensions.
- Punch entries
- Advanced geo-tech studies
- Sinking of 480m deep shaft for return air.
- Pre tensioned cable bolting.
- 11 kV transmission to underground.
- Installation of main fan in underground.
- Transport of heavy longwall equipment by diesel vehicles.
- Floor concreting of punch entry for free steered vehicles (FSV) routing.
- The learning curve delays will only be for the first time and the lessons would be useful to execute other similar projects.
- Surface air chilling plant to supply chilled to UG workings.
- Bolter miner for faster rate of roadway development.
- Pan line bolter for roof supporting in salvage face.
- Foam filling for cavity filling in UG, and
- Tube bundle gas monitoring system

3.7 Ventilation system adopted in the longwall project

- Direct driven main mechanical ventilator of 400 kW capacity being used to cater the ventilation requirements of the mine. Currently it is delivering 200m^3/s air quantity at 100mmwg. An equal capacity fan is installed as standby. Four punch entries of 5.6m × 3.6m are being used as downcast and 400m deep Ø7.5m shaft is used as upcast.
- Booster fans of 55kW are being used in longwall panels and development roadways to circulate air quantity of 40m^3/s to 60m^3/s.
- Auxiliary fans of 90kW to 150kW capacity are being used to deliver an air quantity of 7 m^3/s to 20m^3/s at 0.9kPa to 5.0kPa in conjunction with ducting of Ø900mm to Ø1200mm.
- Initially air chilling plant 1624TR with air handling units (air cooled type) was installed to deliver 50m^3/sec of chilled air at 15ºC, which is circulated exclusively to the longwall face through a dedicated roadway from surface. Due to use of this air cooling system, temperature at longwall face reduced from 33.0ºC to 28.5ºC resulting in improvement is workplace comfort and productivity. For longwall panel-2 air handling units were replaced with bulk air handlers (water cooled) to deliver the chilled air at 9.0ºC. With replacement of the air cooled type chilling system with water cooled type the efficiency of the cooling system was improved considerably.
- For prevention and control of spontaneous heating, various measures are taken such as pro-active inertization by infusion of N_2 and CO_2. Nitrogen generators and cryogenic CO_2 tankers are installed at the mine. Initially, N_2 generators of 800 Cu.m/hour of PSA type and CO_2 storage systems of 30kL capacity were used. Later, 2000 Cu.m/hour capacity membrane type N_2 generator is installed and in operation.
- In-house expertise, reputed national and international scientific institutions (Indian School of Mines (ISM) and CSIRO) are taking part in designing and modelling of ventilation systems (network modelling), air cooling systems (heat flow modeling) and inertization systems (computational fluid dynamics modelling) for optimization.

3.8 Other technical challenges encountered and resolved

3.8.1 Change of working section during drivage of gate roads

Initial drivage

- The gate roads were driven in coal floor as per the working section (1st time) as shown in Fig.3.
- As per this section roof bolts were anchoring in clay band which in turn resulted in reduction of the anchorage capacity of roof bolts.
- As a result roof guttering problem started occurring along the gate roadways.
- Moreover coal floor is not suitable for movement of FSVs which was in turn clarified with consultants too.
- Hence decision was taken to change the working section as shown in the drawing.

Change of working section

- Roof section was lowered by leaving 0.3m coal against 0.75m shale+0.25mclay+0.1m shale.

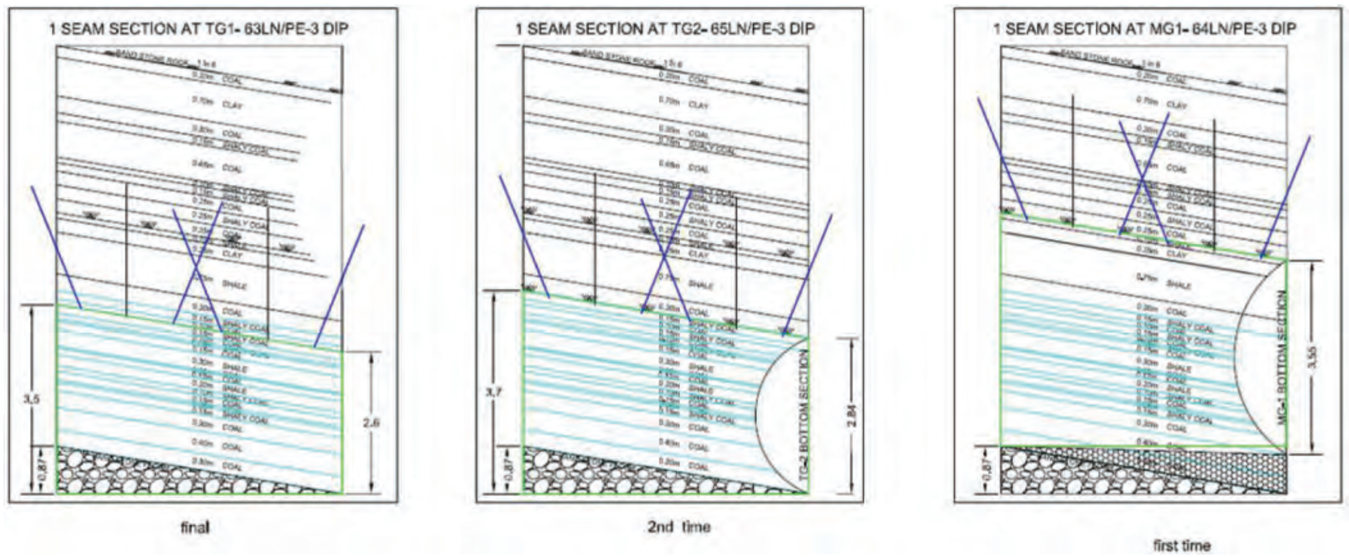

Fig.3 Different working sections of longwall gate road

- Sand stone floor was exposed by cutting the stone floor for FSVs movement. But roof Guttering problem found to be continuing.
- Hence, a decision was taken lower the roof section further to reduce the effect of roof guttering.

Final working section

- It was decided to leave another 0.3m coal against the roof to reduce the effect of roof guttering.
- In total 0.6m of coal layer left against 0.75m shale.
- Roof bolts though were not touching the clay but anchored for more than 50% in shale.
- Hence the problem of roof guttering was not solved by 100% but the time taken for occurrence of guttering and tensile cracks was found delayed after roof exposure.
- The matter was discussed with CSIRO and Consultant Dr.Russel Firth and they advised to install cable bolts.

The advancements in the three working sections were given from right to left in the Fig.3.

3.8.2 Drivage of installation roadway:

The drivage of installation roadway of panel no.1 was done in two stages. During the first stage, it was developed with 5m width and in the second stage it was widened to final 8m width. Due to non-availability of bulbed cable bolts, the first 40m was widened by supporting only with roof bolts with extra density. But sudden convergence was noticed after drivage of 40m and the widening was stopped.

The widening was resumed after supporting with the bulbed cable bolts in the already widened area up to 40m and in the unwidened area before widening. After installation of cable bolts, the convergence was stabilized in the already widened area and the total installation roadway widening was completed successfully without any strata problems and the convergences were within the permissible limits.

3.8.3 Change in orientation of cut-throughs:

Earlier severe strata control problems encountered while driving cut throughs and mitigated after the change in the orientation of their drivage in tune with the major principle stresses as per the advice of Russell Frith, technical consultant of the project from Australia. The orientation of strata and principal horizontal stress were given in Fig.4.

4.0 Conclusions

Mechanised longwall mining has emerged as the most successful production technology in the global coal mining scenario. The effective application of enabling technologies of hydraulics and electronics coupled with the use of heavy duty supports and equipment during last three decades have helped longwall technology to scale new heights of production and productivity.

Many factors contribute to preventing most longwall installations from producing anything but a fraction of their theoretical capacity. Longwall should be promoted as a technology mission, thrust areas are to be given due consideration to succeed longwall technology as in other countries like Australia, USA and China. A high level expert group is to be constituted at national level to promote, coordinate and discuss different aspects related to longwall technology. Training with regard to the problems anticipated in the countries in which such problems are already overcome so as to prepare guidelines for future longwalls. Concrete efforts are required by the mining inspectors, policy makers, coal companies, research organizations and equipment manufacturers to translate the ideas into concrete action and reap the benefits of longwall technology in the years to come.

As the Neil Armstrong says "Though it is a small step for a man but a Giant Leap for Mankind". It is important to note

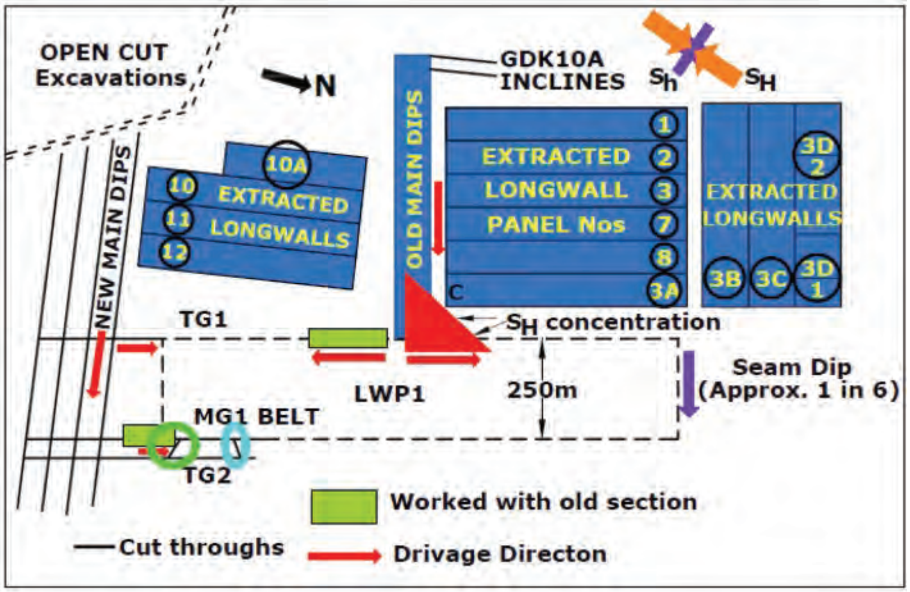

Fig.4 Layout of gate roads and cut throughs w.r.t. principal stress

that success of any longwall project of such magnitude needs meticulous planning right from the prospecting stage of the project, conceptual planning stage and FR preparation stages and subsequently needs to be modified and updated during development and operation phases of the project with proper risk management mechanism in terms of project cost and time overruns with necessary financial provisions. The lessons learnt from the successful implementation of the Adriyala LW project are going to pave the way for new generation longwalls in our country in future.

5.0 Acknowledgements

The authors express their acknowledgements to the publishers of *Journal of Mines, Metals and Fuels* and the views expressed in the paper are those of the authors only and should not be attributed to organization they belong.

6.0 References

1. Ghose, A. K. (1988): "Mechanised Longwall Mining in India – collating the decadal experience (1978-1987)." *Journal of Mines, Metals & Fuels*, June, 1988, pp 267-273.
2. Ghose, A. K. (2003): "Why Longwall in India has not succeeded as in other developing country like China?" *IE (I) Journal*, Vol. 84, Aug 2003, pp 1-4.
3. Venkata Ramaiah, M. S., Sastry, V. R. and Nair, Roshan (2005): "Analysis of the Influence of Contact Roof zone on powered roof supports during extraction by Longwall using F.E.M," *IE(I)*, MN-335.
4. Barczak, T. M. (2006): "A Retrospective Assessment of Longwall Roof Support with a Focus on Challenging Accepted Roof Support Concepts and Design Premises," Proceedings of 25th International Conference on Ground Control in Mining, August 1-3, 2006, Morgantown, West Virginia. pg 232-244
5. Proceedings of the FR (2006) approved by the MoC.
6. Proceedings of the First RCE (2009) approved by the MoC.
7. Prasad M., V. N. S., Siva Sankar, U., Mukhopadhyay, S. K. and Deb, Debasis (2010): "A Retrospective Assesssment of Longwall Mining with a focus on Successful Mechanised Underground Mining Technology." (2010).
8. Kumar, B. Ramesh, Siva Sankar, U. and Prasad, V. N. S. (2011): "Selection of Powered Roof Supports - 2-Leg Shields vis-a-vis 4-leg Chock Shields," International Conference on Underground Space Technolog (ICUST), Bangalore.
9. Sharma, D. N. and Veera Reddy, B. (2015): "Changing trends in geotechnical studies for longwall Panels in different generation at SCCL." *Mining Engineers Journal*, Vol-17, No.-4, pp 18-21.