CHAPTER 5.
FIELD STUDY

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5.1. Background

Field studies are core elements of a geo-technical investigation, mainly due to the existing technical difficulties in proper assessment of rock mass behaviour and in-situ stress field. That is why empirical formulations are popular in the mining industry. In this study, two mines have been selected because of their different operational methodology and roof condition. Both the panel of the mines had instrumented rock bolts. The observed value of the instrumented bolt in depillaring operation is used during the validation process.

5.2. Details of the field studies

Two cases of an underground mine with continuous miner technology and SDL/LHD have been chosen to analyse the model behaviour and validated with the help of observed instrumented rock bolt information available in the mine.

Table 5.1 Description of case

Cases	Name of the Mine
CASE - I	Pinoura Mines, SECL
CASE - II	GDK – 5A Incline, SCCL

5.2.1 Case I: Pinoura Mines, SECL

i. Mine Description:

Pinoura mines of M/S SECL is situated in the Madhya Pradesh state of India. This mine is located in the western part of the Johilla area of SECL. The coal measures of this mine are of the lower Permian stage of the Barakar formation. CM is introduced in this mine to extract L-1B seam, whose thickness varies from 2.8m to 4m (average seam thickness is 3.5m) with a gradient of 1 in 9. Different overlying and underlying formation of L1-B seam as per borehole no. JP-20 is shown in figure 5.1. The L-1B seam is lying at a shallow depth of cover (less than 150m). The seam has a number of faults and geological disturbances.

It is observed that the overlying strata are highly laminated and mainly, consisting alternate layers of sandstone, shale, carbonaceous shale, etc. The immediate roof of the L1-B seam in the panel is observed to be easily cavable. The Cavability index value in this mine is around 2000. The underground working plan of the Pinoura mine is shown in figure 5.2.

General information of the Pinoura Mine, SECL has been summarized in Table no. 5.2.

Table 5.2 Brief information of mines (Pinoura Mine, SECL)

Parameters		**Value**
Method of Working		Bord and Pillar with continuous miner
Thickness	Seam (L-1B)	3.5
	Height of extraction	2.8 m average
Depth of working		162 m
Gallery width		6.0 and 6.5 m
Pillar size		26 × 26
Immediate roof		Carbonaceous shale up to 5.0 m in thickness
Panel No.		CM3
Roof condition		Fair Roof (RMR = 42)

Parameters		**Value**
Cavaebility of roof		weak to moderately difficult to cave
sting support pattern (development)	Gallery	4 bolts in row, spacing is 1.5 m between bolt and row
	Junction	5 bolts in row, spacing is 1.0 m between bolt and row
Goaf edges Support pattern		Roof bolts of 2.4 m length (full column resin grouted) at 1.0 m interval in between the rows and two consecutive bolts
Rock bolt density		2.25 m^2/bolt in gallery 1.44 m^2/bolt in Junction

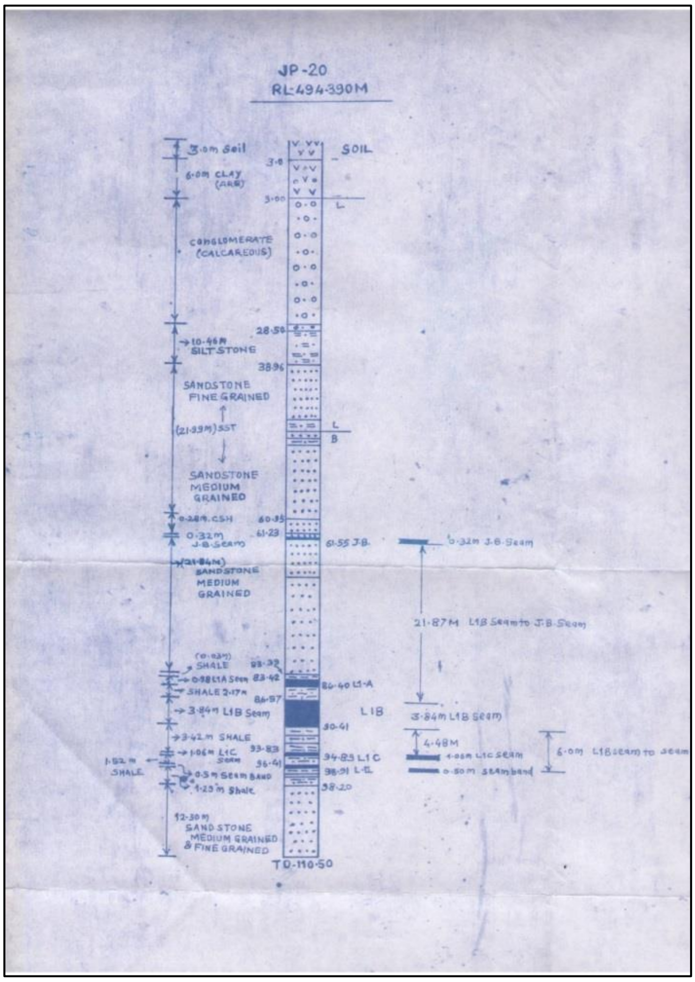


Figure 5.1 Borehole data of Pinoura Mine, SECL

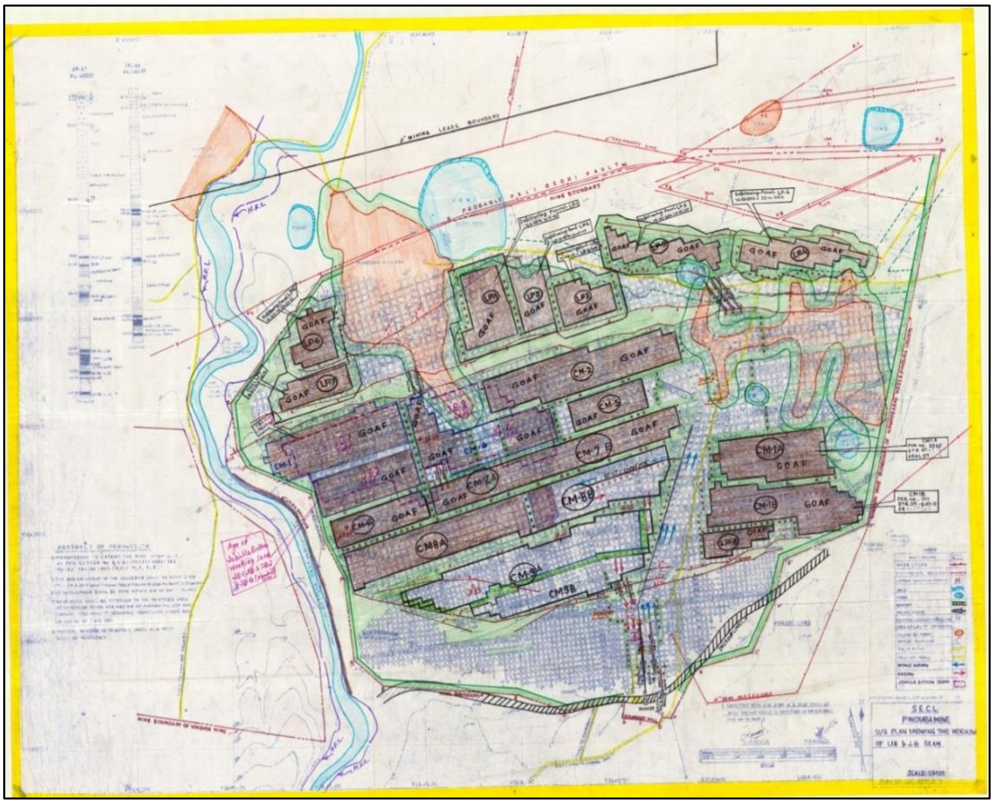


Figure 5.2 Underground working plan of Pinoura Mine, SECL

ii. Bord and Pillar Panel Information

The seam is developed on pillars along the floor by conventional bord and pillar method with maximum 4.8m gallery width leaving 0.5 m coal in the roof for protection of immediate roof failure during operation as shale is present just above the seam. Before the commencement of mechanized depillaring (MD) operation, the existing galleries were widened up to 6.5m by CM in each panel. The layout of the developed pillar is shown in figure 5.3.

Due to the shallow depth of cover, the size of the developed pillar was small. For extraction of such pillars, splitting is not needed. The deployed CM machine was capable of covering the whole of its width from the existing galleries around it. Accordingly, this mine adopted single pass extraction for the whole pillar by the Fish–Tail method as shown in figure 5.4 using CM and Ram car combination.

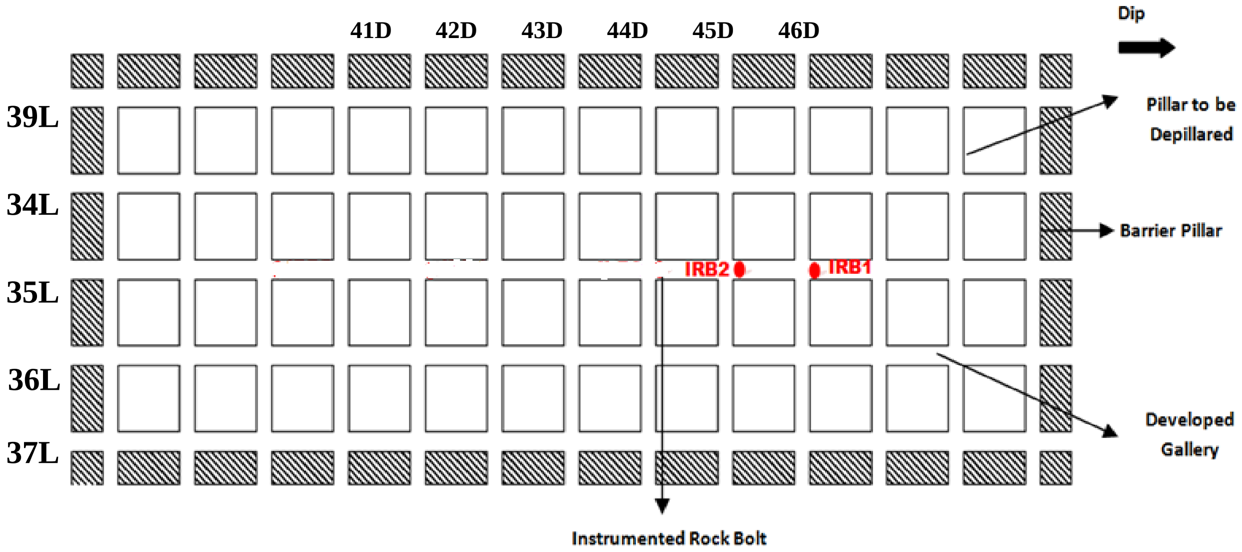


Figure 5.3 Mechanized bord and Pillar panel layout showing location of instrumented rock Bolt.

A pillar is extracted by driving four slices from both level galleries around a pillar. After completion of eight slices (four slices from each level galleries of a pillar), the remnant is extracted by driving two push-outs along the out bye dip rise gallery of the pillar. When a pillar is adversely affected by geological discontinuities, then partial extraction of the pillar is done. Extraction of pillars started from dip end and advanced systems to rise side throughout the panel. As usual, a straight line of extraction is maintained in all these panels.

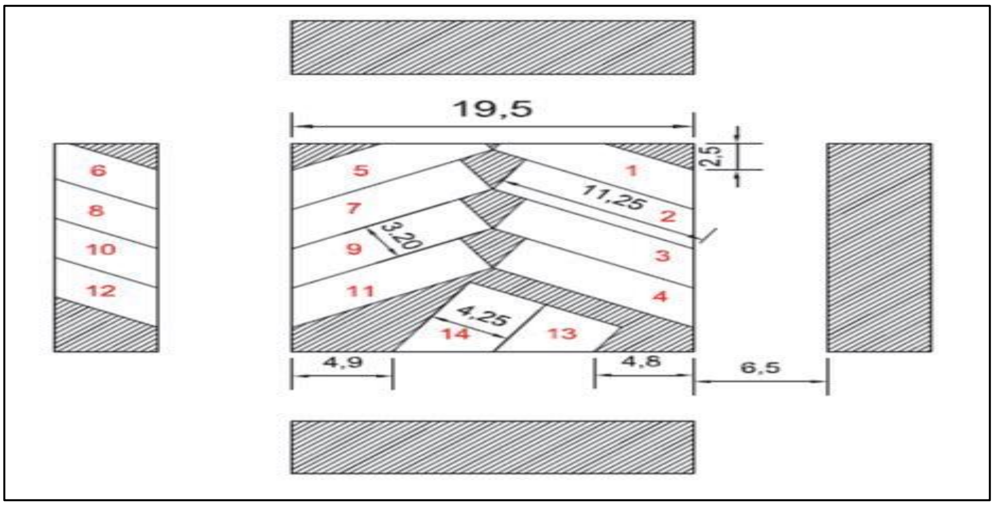


Figure 5.4 Manner of pillar extraction adopted in mechanized depillaring panel at Pinoura mine, SECL

iii. Support Pattern in Mines

Support design adopted in Pinoura mine during development operation is four bolts in a row with an interval of 1.2 m, and spacing between two bolts is 1.5m, as shown in figure 5.5. The length of the bolt was installed in the gallery, and junction is 1.5m.

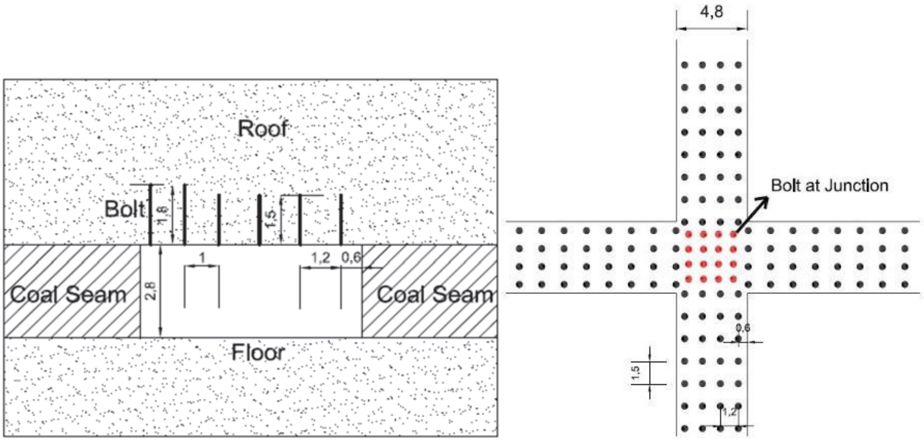


Figure 5.5 Existing support patterns in Gallery and Junction at Pinoura Mine

During depillaring operation, the support pattern is adopted near the goaf edge are two rows of full column resin grouted Roof Bolt Based Breaker Line Support (RBBLS) at 1m grid pattern as shown in figure 5.6.

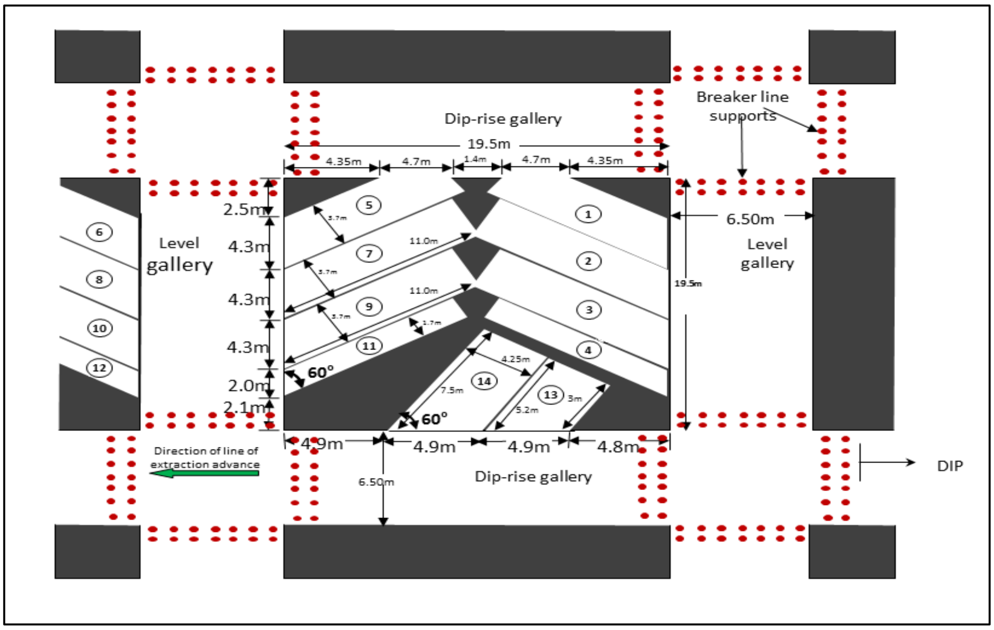


Figure 5.6 Existing support patterns near goaf edge of Pinoura Mine, SECL.

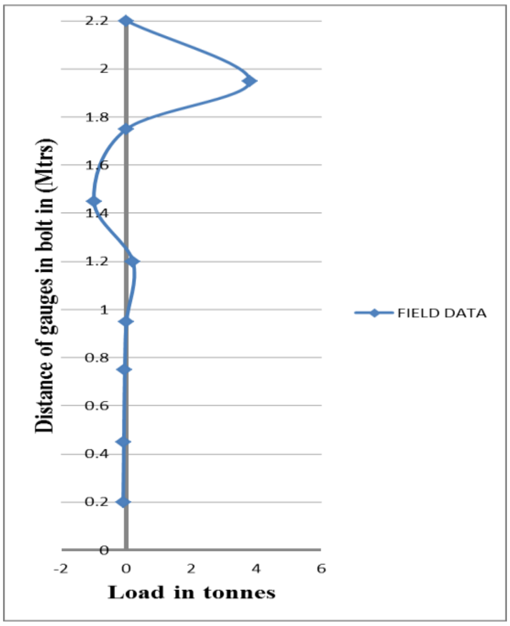
iv. Observed field data of Instrumented rock bolt

Two instrumented rock bolts were installed in the panel to monitor the axial load on the bolt with goaf advancement in the panel. It was installed in between two rows of RBBLS. It was placed at the locations 46D/35L and 45D/35L shown in figure 5.3. The recorded value of instrumented rock bolt is captured for simulation purposes is shown in figure 5.3. The type of instrumented rock bolt used in the CM-6 panel of L1-B seam is shown in figure 5.7.

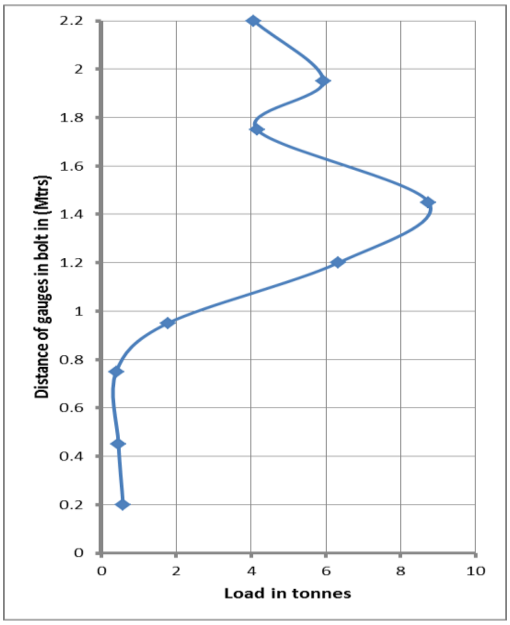
Threaded end of the Bolt	17	15	13	11	9	7	5	3	1
	18	16	14	12	10	8	6	4	2
Bolt Length	Gauge-Pair Position(Mt)								
2.4mt	0.2	0.45	0.75	0.95	1.2	1.45	1.75	1.95	2.2

Figure 5.7 Instrumented Rock Bolt used in Pinoura Mine, SECL

The axial load measured along the length of roof bolts at two different locations, namely 46D/35L (IRB1) and 45D/35L (IRB2) in the panel, is shown in figure 5.8. It has been observed that as the roof bolts reach near the goaf edge, axial load along the length of the roof bolt increased and attained maximum value the moment it entered inside the goaf edge. The maximum load observed was around 8.21 t along the length of the instrumented rock bolts at the location 45D/35L, and recorded data at location 46d/35L is 3.7 tonne.



35L, 46D IRB1



35L, 45D IRB2

Figure 5.8 Recorded data of Instrumented rock at Pinoura Mine, SECL

5.2.2 Case II: GDK – 5A, SCCL

i. General Information of Mines

GDK.No.5 underground mine started on 12-06-1961 and operating with a capacity of 0.36 MTPA with a mine take area of 532.43 Ha. Presently GDK No.5 incline mine is operating with Bord and Pillar method of mining with LHDs. It is proposed to enhance the production capacity from 0.36 MTPA to 0.6 MTPA by improving the performance of existing LHDs without increasing the mine take area. This project is also aimed at extracting coal from underground through an inclined tunnel without causing disturbance to the surface features lying over the property by adopting sand stowing practice. General information of the GDK-5A Mine, SCCL, has been summarized in table 4.3.

Table 5.3 Brief information of Mine GDK – 5A, SCCL

Parameters	**Value**	
Method of Working	Bord and Pillar with SDL/LHD working	
Seam Thickness	4.0 – 4.5 m	
Depth of working	180m	
Gallery width	4.2 m	
Pillar size	32 m center to center	
Immediate roof	dium grained sandstone up to 30 m in thickness	
Roof condition	Good Roof (RMR = 52)	
Cavability of roof	Moderate to difficult to cave	
Existing support pattern	Gallery	3 bolts in row, spacing is 1.2 m between bolt and row
	Junction	4 bolts in row, spacing is 1.0 m between bolt and row
Rock bolt density	1.44 bolt/m^2 in gallery 1 bolt/m^2 in Junction	

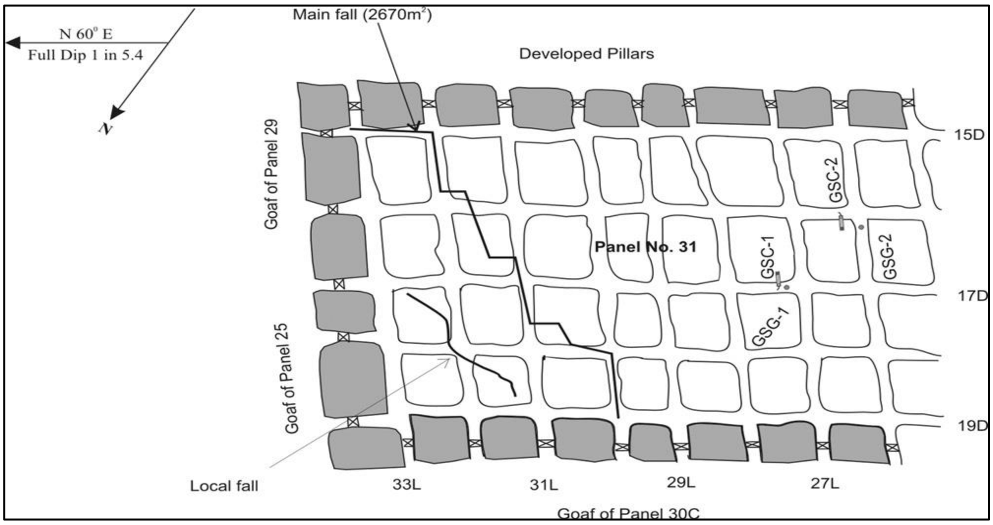


Figure 5.9 Plan of Panel no. 31, GDK – 5A Incline, SCCL (Kushwaha et al., 2010)

ii. Support Pattern in Mines

At the GDK-5A incline of SCCL, the conventional split and slice method of extraction were being performed manually for developed pillars. During the depillaring operation, they were using three bolts in a row at a spacing of 1.2 m in split galleries and two wooden props in a row at a spacing of 1.2 m in each slice as a support system. In addition to that, a wooden cog was also erected at the center of the slice junction. At goaf edge, three sets of wooden cogs were erected skin to skin, as shown in figure 5.10. Induced caving was performed at regular intervals of face advance, so that chances of overriding could be avoided.

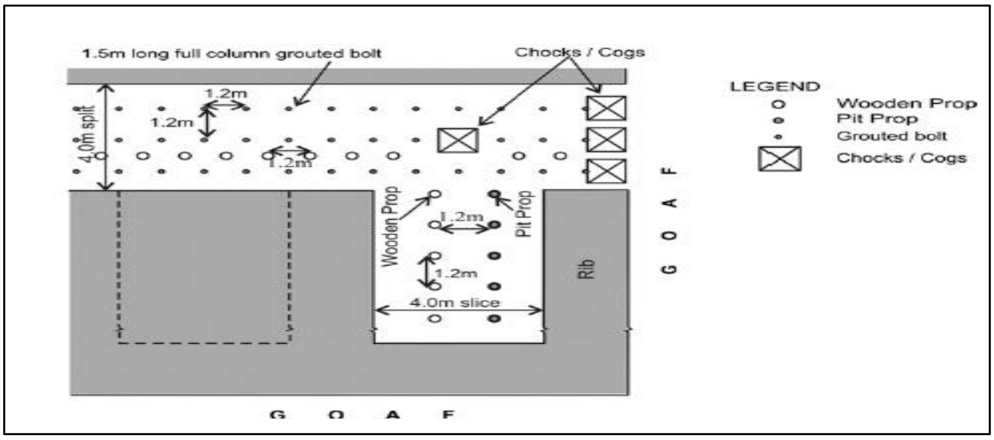


Figure 5.10 Existing support patterns near goaf edge at GDK – 5A Incline, SCCL

iii. Observed Results of Instrumented rock bolt

The plan showing instrumented rock bolt location is shown in figure 5.5. The maximum recorded axial load observed at location GSG1 is about 13.4 tonne when the goaf reaches 1 m from the bolt location.

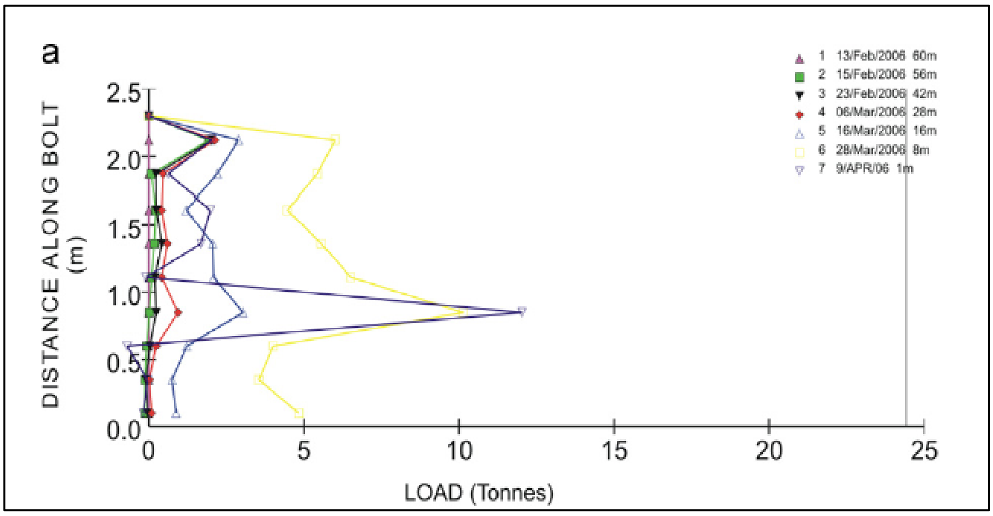


Figure 5.11 Recorded data of Instrumented rock at GDK-5A, SCCL

5.2.3 Summary

The present Chapter discussed the brief information of two cases taking into consideration in this study. Brief information of the mine has been discussed. The manner of extraction of both the mine is different, chosen for study to accomplish the variety in the simulation process. Geo-mining conditions of both the mines vary in terms of RMR, depth of cover, and gallery size. Support design is being discussed during development as well in depillaring operation. Instrumented rock bolt data has been recorded in both the mine at various locations in the panel. The monitored value has validated with the instrumented rock bolt. The details have been discussed in Chapter 6.