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RESERVE ESTIMATION OF PROPOSED OPENCAST MINE OF RAMNAGORE COLLIERY

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ABSTRACT

As jhama and burnt coal are saleable items with sizeable demand in different small and medium scale industries, the management of Ramnagore Colliery of Steel Authority of India Ltd. (SAIL) has decided to mine jhama, burnt coal, coal and the strata of jhama intruded by mica peridotite from Salanpur D-2, Salanpur D-1 and Salanpur C seams in a block near north-eastern boundary of the colliery, covering a total area of around 22.01 hectare. The proposed mine is located in Ramnagore part of Indikatta-Ramnagore Block on the eastern bank of the Barakar River in Raniganj Coalfield. This paper describes the methodology of reserve estimation along with estimation of pit life, waste and stripping ratio.

Geological report by Central Mine Planning & Design Institute Ltd. (CMPDI) in 1995 forms the basis of the geological information of the area. The report indicates that due to pyrolysis, the seams have been transformed into a combination of layers of jhama, burnt coal, coal and the layers of jhama intruded by mica peridotite. Of the 15 boreholes in and around the proposed opencast mining site, lithologs of only 13 boreholes are available with the mine management and only 8 boreholes fall inside the proposed mining area. The classification of seams in the lithology of the boreholes is neither very clear, nor very convincing.

The results indicate that it would be much more economic to mine the site en bloc than to mine Western and Eastern blocks separately leaving a 90 m wide barrier in between them to protect the existing high voltage electric supply line. In isolation, the West Block, which covers nearly two-third of the whole site, will run for two-and-half years, producing a little more than 40% of the total mineable reserve of the whole site and generating 63% of the total waste likely to be generated had the whole site been mined as one. Overall stripping ratio of the Western Block will be 8.36 m^3/t, i.e. nearly one and half times of the stripping ratio of 5.47 m^3/t expected for the mining of the whole site in one go. The Eastern block that covers only about 15% of the whole site will result in production for only two months. The production will comprise not even 3% of the total mineable reserve in the whole site, that too with a high overall stripping ratio of 12.82 m^3/t. On the other hand, if the whole site is mined en bloc, the mine is likely to run for six years yielding more than 0.7 million tonne of minerals (coal, burnt coal and jhama together) with a stripping ratio of 5.47 m^3/t approximately.

Key Word: Coal, Reserve Estimation, Opencast Mining

INTRODUCTION

Ramnagore Colliery of Steel Authority of India Ltd. (SAIL) is located in Ramnagore part of Indikatta-Ramnagore Block on the eastern bank of the Barakar River in Raniganj Coalfield. Three seams, namely Salanpur D-2, Salanpur D-1 and Salanpur C, outcrop/incrop near the northern and northeastern boundary of the colliery where a few major faults run drawing natural limits of mining (Ghose etal 2007). As reported by the Exploration Division of Central Mine Planning & Design Institute Ltd. (CMPDI in 1995) in their Geological Report on Exploration for Coal in Indikatta-Ramnagore Block, most of the coal seams in this block have been affected by sills and dykes of mica peridotite to a varying extent. Consequently, the mining potential of the coal seams has been impaired. All

seams have been mostly pyrolysed in the entire block. However, only the bottom part of Salanpur C seam is available in a small area along northeastern boundary of the block. The colliery management has decided to mine *jhama*, burnt coal, coal and the strata of *jhama* intruded by mica peridotite from Salanpur D-2, Salanpur D-1 and Salanpur C seams near northeastern boundary of the proposed colliery, shown as ABCDEFGHIJ in Fig. 1, covering a total area of around 22.01 hectare.

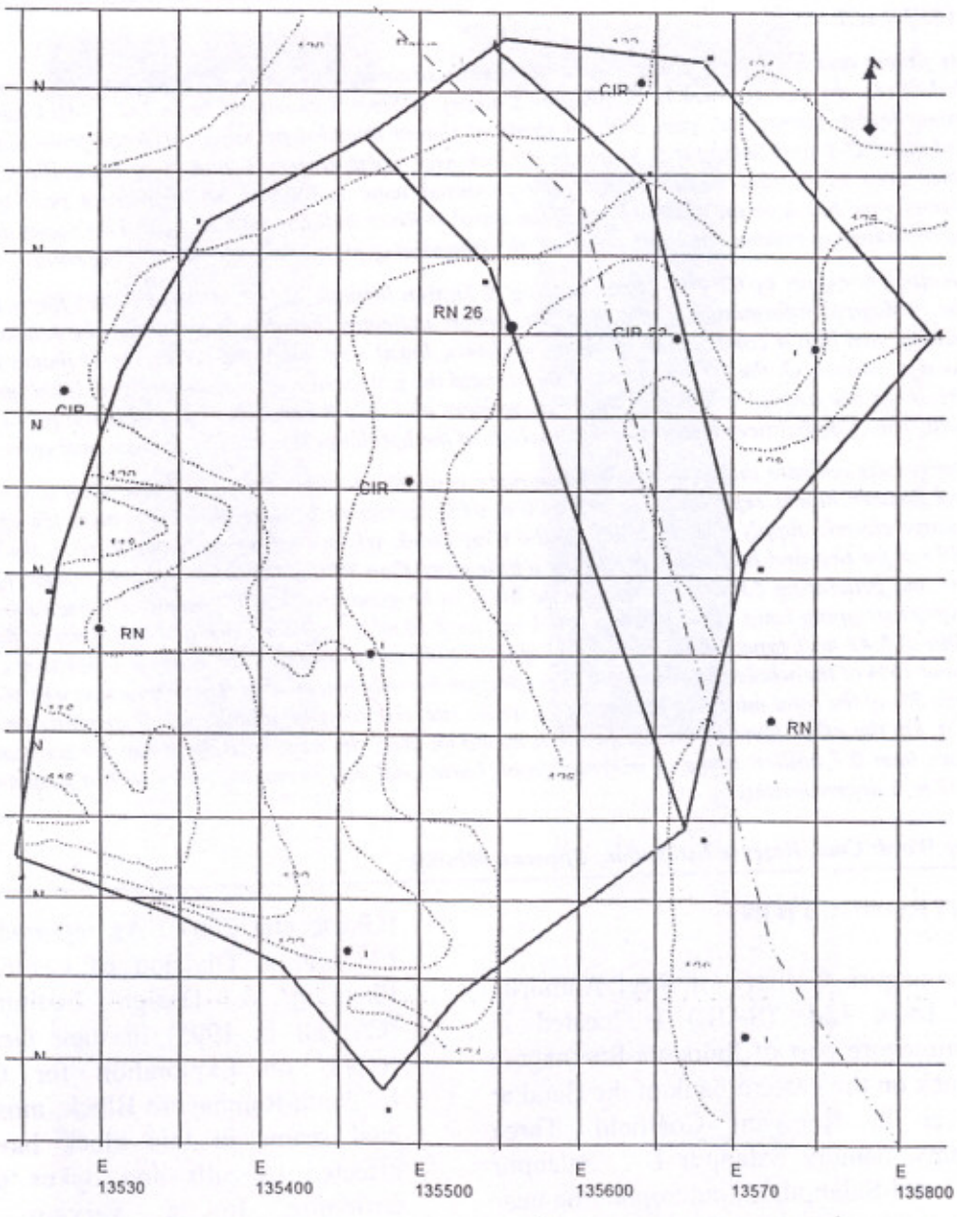

Fig. 1: Part plan of Ramnagore Colliery showing the proposed site ABCDEFGHIJ for surface mining of Salanpur D2, Salanpur D1 and Salanpur C seams

An overhead high tension electric supply line runs obliquely across this area. It is being planned to shift this electric line beyond the area ABCDEFGHIJ, leaving a minimum margin of 45 m from its boundary at any point. However, it has also been alternatively thought that if the high tension line cannot be shifted, the area ABCDEFGHIJ will be worked in two blocks, namely EFGHIJK and ABCDL, of area in the order of 14.68 hectare and 3.24 hectare respectively, leaving a 90 m wide ALDEKJ space of about 4.09 hectare area below the high tension electric line unmined to keep the limits of mining excavations at a minimum distance of 45 m from the present position of this high tension line (Fig. 1). The production from this mine is proposed at the rate of 11,200 tonnes per month.

DATA ACQUISITION AND FIELD OBSERVATION

Relevant topographical and geological information were obtained from the Geological Report prepared by CMPDI. Site visit was undertaken to collect on-field information about the seams and geological features encountered in the already opened portion of the proposed mine. Supplementary information such as proposed location of the mine opening, quality of the coal and typical proportion of recovery of mineral from the layers of *jhama* intruded by mica peridotite was obtained by discussion with the mine official. These are summarised below:

The ground surface is mildly undulating with a gentle slope towards south-west. Block EFGHIJK has already been opened at its northern end, near the points I, J and K (Fig.1). Exposures in existing mining excavations indicate existence of local faults within the study area. Frequent faulting has resulted in irregularity in dip and thickness of seams in this area, making the precise identification of seams very difficult. Though general dip of the concerned seams in this area is along S 18^{O} W, the seam/s appeared to be much steeper and varying in direction at the site where the mine has been opened.

Core drilling was conducted in 15 boreholes in and around the proposed mining site. Of these boreholes, only 8 boreholes are inside the proposed mining area. Rest 7 boreholes are located outside the concerned area. Five of these boreholes are located 120 to 155 m away from the area ABCDEFGHIJ, on east or on west, while the maximum stretch of this area along east-west at any place does not exceed 490 m. Lithologs are available with the mine management for 13 boreholes (Table 1).

Table 1: Core drilled boreholes in and around the proposed opencast mining site

CORE-DRILLED BOREHOLES INSIDE AREA ABCDEFGHIJ		CORE-DRILLED BOREHOLES OUTSIDE AREA ABCDEFGHIJ	
Borehole	**Location**	**Borehole**	**Location**
IK-2**	Near the southern extreme	IK-1	On southeast corner, about 130 m away
IK-4**	On N 103350, near the middle of the width	IK-3	120 m away from the eastern boundary
IK-5**	About 70 m inside the eastern extreme	IK-8T	On N 103450, about 155 m away on west
CIR-21**	Near the centre	CIR-10	On N 103290, about 125 m away on west
CIR-22**	Near N 103550, E 135650	CIR-19**	About 35 m away on west
CIR-24**	Near the northern extreme		
RN-26X	Almost along N 103600, in the middle	RN-22**	40 m away on the east
RN-29**	Near the western boundary	DB-4X	155 m away from the eastern boundary
** Refer Fig. 1		X No data available	

Eight boreholes (out of which no data is available for borehole RN-26) inside the proposed mining area are too less in number compared to the geological disturbances present in this area. Further, these boreholes are irregularly placed. It is more so in its southern part. While the proposed mining area extends from the south of N 103100 to beyond N 103700, there is only one core-drilled borehole, viz. IK-2, inside the property on the south of N 103350. Floor contour of Salanpur C seam is not available with the mine management. The classification of seams in the lithology of the borehole logging is not very convincing. The mine management conducted some non-core drilling primarily in the northern part of the area. However, information available from these boreholes is of little use. Mine management has no programme for fresh/additional exploratory drilling in this area. The problem therefore is complicated because of geological complexity of the site and inadequate geological database available with the mine management.

METHODOLOGY

As it is not possible to isolate the three seams very clearly and reliably from the available lithologs, especially the locations of their incrop/outcrop, all the three seams are taken together as "mineralised zone".

The mine officials intimated that 100% of layers of coal, burnt coal and *jhama* are recoverable. They also informed that

from the layers of *jhama* intruded with mica peridotite usually 30 to 40% is recovered. Accordingly in our estimation percentage of recovery is considered as 100, 100, 100 & 30 for coal, burnt coal, *jhama* and *jhama* with mica peridotite respectively. The average density of recoverable mineral is uniformly taken as 1.4 t/m^3 (estimate of average density of 1.4 t/m^3 is provided by the mine management).

From the available lithologs and data, for each of the thirteen boreholes mineralised zone has been identified, depth of overburden has been determined, and percentage of recoverable mineral and amount of interburden have been estimated.

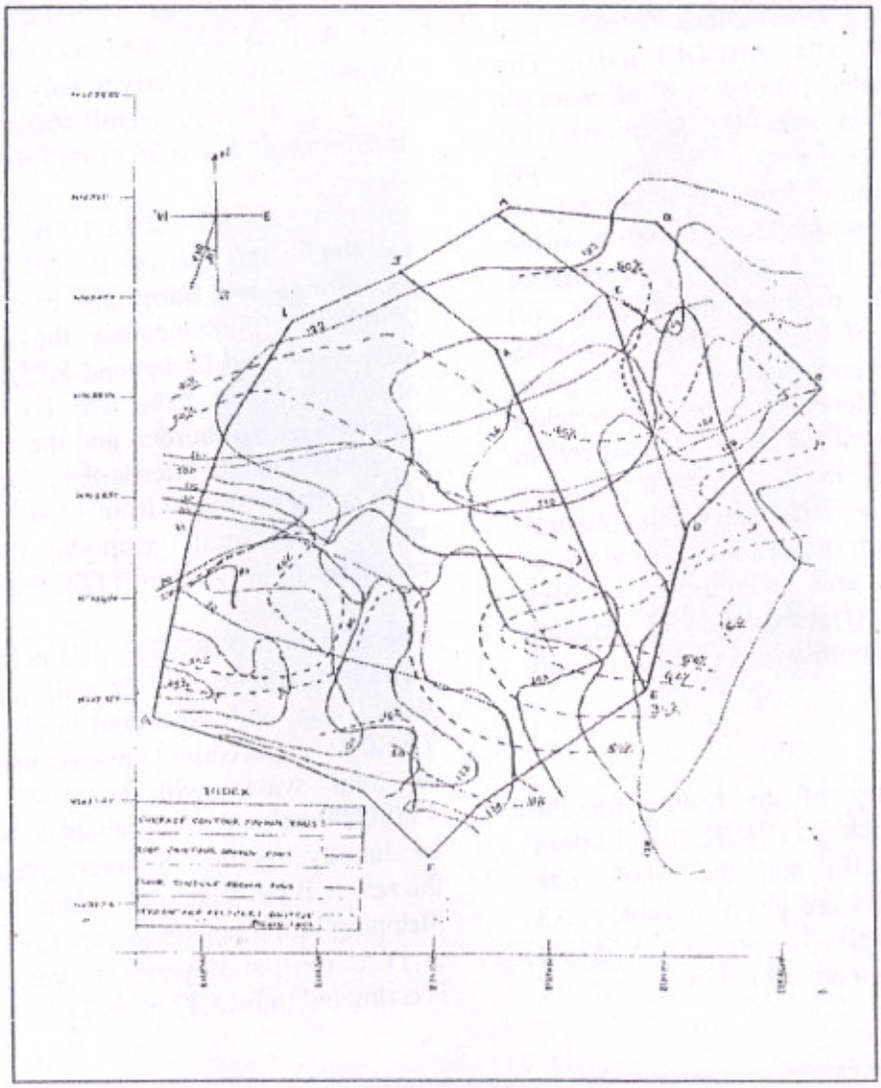

Figure 2: Part plan of Ramnagore Colliery showing surface contour; contours of roof, floor and mineral recovery percentage of mineralised zone in ABCDEFGHIJ

Using data available for 13 boreholes, 18 sections are drawn to extrapolate the data to cover the whole area. Contours of roof, floor and recovery percentage of the mineralised zone for the area ABCDEFGHIJ are prepared (Fig. 2).

Considering mining down the dip, the whole exercise was carried out by taking up the calculation for one block in each stage (the blocks are Western Block EFGHIJK, Eastern Block ABCDL, and the whole site ABCDEFGHIJ). The steps included (a) design of ultimate pit configuration with 45^{O} as ultimate pit slope gradient, without any consideration of benching in ultimate pit slope, (b) preparation of a section of the block along the average dip direction of the seam/s or mineralised zone, (c) estimation of total recoverable mineral, interburden and overburden in the given block, (d) identification of the stretches of the mineralised zone to be mined in each month in the block to produce 11,200 tonnes of recoverable mineral, (e) estimation of corresponding yields of overburden and interburden in each month, and (f) calculation of stripping ratio, both month-wise as well as overall.

RESULTS

The summary of the results for the Western Block EFGHIJK, the Eastern Block ABCDL, and the whole site ABCDEFGHIJ are given in Tables 2, 3 & 4 respectively. The production of first month is planned a bit low in case of blocks EFGHIJK and ABCDEFGHIJ to take care of the ancillary work involved during opening of the mine.

Life of the pit EFGHIJK is about 2.5 years. In this period it will produce *jhama*, coal and burnt coal in excess of 3,20,000 tonne. Simultaneously the yield of total waste will be beyond 27,00,000 m^3, of which more than 75% will be directly obtained as overburden and the rest will be generated as interburden. Stripping ratio is likely to vary from 5.14 to 16.83 m^3/t, and overall stripping ratio is estimated to be 8.36 m^3/t (Table 2).

Life of the pit ABCDL is about 2 months.In this period it will produce *jhama*, coal and burnt coal in excess of 22,000 t. Simultaneously the yield of total waste will be beyond 2,85,000 m^3, of which about 85% will be directly obtained as overburden and the rest will be generated as interburden. Stripping ratio is likely to vary from 11.40 to14.23 m^3/t, and overall stripping ratio is estimated to be12.82 m^3/t (Table 3).

Life of the pit ABCDEFGHIJ is about 6 years. In this period it will produce *jhama*, coal and burnt coal in excess of 7,85,000 tonne. Simultaneously the yield of total waste will be more than 43,00,000 m^3, of which about 65% will be directly obtained as overburden and the rest will be generated as interburden. Stripping ratio is likely to vary from 0.99 to 11.52 m^3/t, and overall stripping ratio is estimated to be 5.47 m^3/t (Table 4).

Table 2: MONTH-WISE ESTIMATED PRODUCTION AND STRIPPING RATIO FOR EFGHIJK BLOCK

Month	Production (t)	Overburden (m^3)	Interburden (m^3)	Total Waste (m^3)	Stripping Ratio (m^3/t)
1	9822.4	91691	3309	95000	9.67
2	11200	52910	30525	83435	7.45

Table 2: MONTH-WISE ESTIMATED PRODUCTION AND STRIPPING RATIO FOR EFGHIJK BLOCK					
Month	Production (t)	Overburden (m^3)	Interburden (m^3)	Total Waste (m^3)	Stripping Ratio (m^3/t)
3	11200	53760	30464	84224	7.52
4	11200	54259	29455	83714	7.47
5	11200	63819	35280	99099	8.85
6	11200	71415	31740	103155	9.21
7	11200	67500	25650	93150	8.32
8	11200	80141	31778	111918	9.99
9	11200	64110	24859	88970	7.94
10	11200	78738	21474	100212	8.95
11	11200	81329	20791	102120	9.12
12	11200	72696	21216	93912	8.39
13	11200	99376	28598	127974	11.43
14	11200	108308	29273	137581	12.28
15	11200	129235	20223	149458	13.34
16	11200	75480	16983	92463	8.26
17	11200	104219	20781	125000	11.16
18	11200	73900	17428	91328	8.15
19	11200	102770	22705	125475	11.20
20	11200	43644	13914	57558	5.14
21	11200	57459	11556	69015	6.16
22	11200	53566	14410	67975	6.07
23	11200	29925	8400	38325	3.42
24	11200	74494	21406	95900	8.56
25	11200	35018	22511	57529	5.14
26	11200	54844	21206	76050	6.79
27	11200	43885	12048	55932	4.99
28	11200	40325	14832	55157	4.92
29	11200	89284	38360	127643	11.40
30	1739.36	21233	8046	29279	16.83
Overall	3,25,161.76	20,69,329	6,49,219	27,18,548	8.36

Table 3: MONTH-WISE ESTIMATED PRODUCTION AND STRIPPING RATIO FOR ABCDL BLOCK					
Month	Production (t)	Overburden (m^3)	Interburden (m^3)	Total Waste (m^3)	Stripping Ratio (m^3/t)
1	11200	123165	36210	159375	14.23
2	11149	119533	7568	127101	11.40
Overall	22,349	2,42,698	43,778	2,86,476	12.82

Table 4: MONTH-WISE ESTIMATED PRODUCTION AND STRIPPING RATIO FOR ABCDEFGHIJ BLOCK

Month	Production (t)	Overburden (m^3)	Interburden (m^3)	Total Waste (m^3)	Stripping Ratio (m^3/t)
1	7489	5658	1733	7390	0.99
2&3	22400	43999	13846	57845	2.58
4 &5	22400	35256	26709	61966	2.77
6&7	22400	39690	27783	67473	3.01
8&9	22400	37180	25350	62530	2.79
10&11	22400	34425	20655	55080	2.46
12&13	22400	49000	27125	76125	3.40
14&15	22400	43341	23447	66787	2.98
16&17	22400	56840	31084	87924	3.93
18&19	22400	51480	29304	80784	3.61
20&21	22400	61250	32375	93625	4.18
22&23	22400	61681	33881	95563	4.27
24&25	22400	73256	43151	116406	5.20
26&27	22400	57453	47235	104688	4.67
28&29	22400	69956	42656	112613	5.03
30&31	22400	92138	60328	152466	6.81
32&33	22400	65258	45529	110787	4.95
34&35	22400	73624	55006	128630	5.74
36&37	22400	91448	71925	163373	7.29
38&39	22400	64484	48020	112504	5.02
40&41	22400	80379	50237	130616	5.83
42&43	22400	84126	43160	127286	5.68
44&45	22400	119543	53130	172673	7.71
46&47	22400	154733	62790	217523	9.71
48&49	22400	163703	67275	230978	10.31
50&51	22400	181276	76832	258108	11.52
52&53	22400	117322	48132	165454	7.39
54&55	22400	128194	51600	179794	8.03
56&57	22400	123600	50985	174585	7.79
58&59	22400	101000	42925	143925	6.43
60&61	22400	87400	38238	125638	5.61
62&63	22400	69400	32098	101498	4.53
64&65	22400	88468	42335	130803	5.84
66&67	22400	56942	27115	84057	3.75
68&69	22400	78030	38097	116127	5.18
70&71	18063	86909	43943	130851	7.24
Overall	7,87,152	28,28,436	14,76,032	43,04,468	5.47

LIMITATIONS

Due to insufficiency of geological data that would be needed for evaluation of reserve and waste, and thus the estimation of stripping ratio for such small patches with so much of geological disturbances, the results may vary from the reality to an extent of ± 20%.

The recovery of *jhama* from the layers of *jhama* intruded by mica peridotite has been taken as 30%, the minimum recovery percentage suggested by the mine authority. However, if the actually recovery is closer towards 40%, mineral production will increase and consequently waste generation will reduce, leading to reduction of the stripping ratio from the estimated value.

DISCUSSIONS AND CONCLUSION

The results indicate that, it would be much more economic to mine the site en bloc than to mine Western and Eastern blocks separately leaving a 90 m wide barrier in between them to protect the existing high voltage electric supply line. In isolation, the West Block, which covers nearly two-third of the whole site, will run for two-and-half years, producing a little more than 40% of the total mineable reserve of the whole site and generating 63% of the total waste likely to be generated had the whole site been mined as one. Overall stripping ratio of the Western Block will be 8.36 m^3/t, i.e. more than 50% higher compared to the stripping ratio of 5.47 m^3/t expected for the mining of the whole site in one go.

The Eastern Block that covers only about 15% of the whole site will yield for only two months and produce not even 3% of the total mineable reserve in the whole site, that too with a high overall stripping ratio of 12.82 m^3/t. Compared to the mineral production, mine life and overall stripping ratio of the Western Block alone, there is slight deterioration in the corresponding values if Eastern and Western Blocks are put together. However, as the Eastern Block is too small, the changes are not significant.

On the other hand, if the whole site is mined en bloc, the mine is likely to run for six years yielding more than 0.7 million tonne of minerals (coal, burnt coal and *jhama* together) with a stripping ratio ranging from 5.47 m^3/t approximately.

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