SUITABILITY STUDY OF SURFACE MINER IN INDIAN COAL MINES

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY
IN
MINING ENGINEERING

BY
Abhijit Sahoo
109MN0126

Dept. of Mining Engg.
National Institute Of Technology
Rourkela- 769008
2013

SUITABILITY STUDY OF SURFACE MINER IN INDIAN COAL MINES

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY
IN
MINING ENGINEERING

BY
Abhijit Sahoo
109MN0126

Under the Guidance of
Prof. H.K.Naik

Dept. of Mining Engg.
National Institute Of Technology
Rourkela- 769008
2013

NATIONAL INSTITUTE OF TECHNOLOGY
2013

CERTIFICATE

This is to certify that, the thesis titled "**SUITABILITY STUDY OF SURFACE MINER IN INDIAN COAL MINES**" submitted by Sri Abhijit Sahoo in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Mining Engineering at National Institute of Technology is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the report has not been submitted to any University/Institute for the award of any Degree or Diploma.

Date: 08/05/2013

Prof. H.K.Naik
Dept. of Mining Engg.
National Institute of Technology
Rourkela- 769008

ACKNOLEDGEMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them.

I take this opportunity to express my profound gratitude and deep regards to my guide Professor H.K.Naik, for his exemplary guidance, monitoring and constant encouragement throughout the course of this thesis. The blessing, help and guidance given by him time to time shall carry me a long way in the journey of life on which I am about to embark.

I also take this opportunity to express a deep sense of gratitude to the manager of Lakhanpur Opencast mine, Samleswari mine, Basundhara mine and Belpahar mine for their cordial support, valuable information and guidance, which helped me in completing this task through various stages.

Lastly, I thank almighty, my parents, friends and colleague for their constant encouragement for developing the project and people who have willingly helped me out with their abilities.

Date: 08/05/2013

Abhijit Sahoo
109MN0126
Discipline: Mining Engineering

CONTENTS

Sl. No.	Topics	Page No
1	Certificate	i
2	Acknowledgement	ii
3	Abstract	iv
4	List of Figures	vii
5	List of Tables	viii
6	Chapter 1: Introduction	1-3
7	Chapter 2: Literature review	4-24
8	Chapter 3: Development of a Computer Program Using C for comparing the suitability of surface miner	25-28
9	Chapter 4: Safety and Advantages of Surface Miner	29-31
10	Chapter 5: Conclusion and scope for future studies	32-34
11	Chapter 6: References	35-36

ABSTRACT

Earlier opencast coal mining activities were done or being carried out only by conventional system of mining which includes drilling, blasting and crushing. All these operations are resulting a lot of adversative impacts on the environment and the surrounding atmosphere.

The adverse impacts that the conventional mining system results are ground vibration, noise pollution, air pollution, land degradation, ecological disturbances etc.

This generates necessity of additional machineries and manpower, eventually cost of mining coal rises. And also due to existence of villages adjacent the mines, blasting is limited as a result massive quantity of coal is blocked. And we all know that quality of coal has great concern in our country since most of the coal seams comprise low-grade quality of coal due to drift origin. Government legislation also forbids the dispatch of coal for more than 1000 Km if coal comprises more than 36% ash.

In these circumstances, surface miner was being introduced which can capable of solving the above declared problems. This allows the operator of the mine to ensure selective mining of coal so that quality of coal develops. The variety of thinner seams which are unworkable in conventional system of opencast mining now converts workable and the whole reserve of non-renewable source of fossil fuel rises. It also decreases cost of production so that total profit of a mine growths.

METHODOLOGY:

To do the objective of this project, the following methodologies are used.

- Literature gathering.
- Collection of details from 4 different mines.
- Designing a C Program viewing suitability comparison among the 4 mines.

OBJECTIVE:

- Why surface miner is suitable, not the conventional mining system.
- Effect of utilization of surface miner on economics of mine.
- Effect of disposition of surface miner on the quality of coal.
- What is the assessment of environmental effect due to placement of surface miner in the mine.
- Suitability for overview of surface miner in Indian geo-mining circumstances.

REASONING FOR THE STUDY:

As I have already mentioned that the earlier used conventional system of opencast coal mining yields lots of adversative effect on environment. And this also needs large number of HEMM for drilling, blasting, excavating and crushing so that requirement of machineries and manpower rises. These increase cost of mining of coal. Also in Indian geo-mining situations huge numbers of stone/dirt bands are existing in coal seams. Throughout blasting, these bands mix with coal so that quality is further worsened. The thinner coal seams are not minable with the help of conventional system of coal mining so that non-renewable source of energy is misused. Starting of surface miner in these conditions resolves all the above stated problems. Here surface miner cuts coal, size and loads in one single pass which excludes the necessity of HEMM for drilling, blasting, excavating and crushing etc. also when we do selective mining of thinner coal seams the quality of coal improves.

In India population is very high and most of the coal mines are bounded by some villages which limits blasting operation in the mine so that massive quantity of coal is blocked. Meanwhile demand of coal for creating electricity and other industrial resolution is very high which need substitute method to remove coal securely without affecting the villagers. The surface miner is one of the best substitute method of mining coal since it advances quality, decrease cost of production and also environmentally friendly.

PREDICTABLE INPUT FROM THE STUDY:

1. To comparise the changes in the production of the mine after utilization of surface miner with the conventional system of mining of coal.

2. To evaluate the decrease of adversative effect on environment after the introduction of surface miner in the mine.

3. To estimate the possibility of working of non-workable seems after introduction of surface miner.

4. To measure the development in principles of safety after the introduction of surface miner.

5. For making the mine operator conscious of several advantages of mining by surface miner in comparison to the conventional system of mining.

6. For assessing the development in quality of extracted coal by surface miner as compared to the conventional system of mining.

LIMITATIONS:

This particular study contains the following limitations:-

1. This study is restricted to specific geo-mining conditions of particular mines.

2. This Study is partial to surface miners of 2100 SM, 2200 SM, 2500 SM, 4200 SM model of Wirtgen surface miner and also KSM 303 and KSM 304 of L & T surface miner. The cost and production will differ with different model of surface miner.

LIST OF FIGURES

Fig. No	Topics	Page number
2.1	Surface miner (machine with middle drum configuration)	5
2.2	Surface miner (machine with front cutting boom)	6
2.3	Surface miner (machine with front cutting wheel)	7
2.4	Trenching by surface miner	9
2.5	Wirtgen 2200SM surface miner	20
2.6	KSM-303 surface miner of L & T	23
2.7	KSM-304 surface miner of L & T	23
2.8	Production output of samleswari ocp by C programming	27
2.9	Production output of belpahar ocp by C programming	27
2.10	Production output of Lakhanpur ocp by C programming	28
2.11	Production output of basundhara ocp by C programming	28

LIST OF TABLES

Table No.	Table Name	Page No
2.1	Various types of surface miner	7
2.2	Comparison of surface miner with conventional mining method	10
2.3	rating of parameters which influences surface miner	13
2.4	effect of CI on surface miner	13
2.5, 2.6, 2.7, 2.8 & 2.9, 2.10	Monthly surface miner performance report of belpahar mines	16-18
2.11	Details of surface miners used in samleswari, belpahar, Lakhanpur and basundhara ocp	19
2.12	Specification of Wirtgen surface miners	20
2.13	Specification of Wirtgen 2100SM	21
2.14	Specification of Wirtgen 2200SM	22
2.15	Specification of L & T surface miner	23

CHAPTER-1

INTRODUCTION

INTRODUCTION:

As we know that, in the whole world India is the third largest coal producing country and at about 88% of production of coal being extracted from these open pit mining. As usual the conventional system of mining coal by open cast mining method includes drilling, blasting, excavating and crushing. The HEMM which comprises in those various processes are Shovel, Drill machines, Grader, Dozer, Dumper, and Dragline. Earlier, as it is mentioned that mining operations are always associated with fatal effect of land degradation, environmental disorders, noise and air pollution and it results to overall environmental corrosion. Blasting process which is also carried out, give rise to blast-induced ground vibrations, disturbance to water regimes., air-blast, fly rock, blasting fumes, dust cloud, noise, and damage to nearby structures. Crushing and drilling operations also cause a lot of dangerous environmental complaint and harmful results such as air and noise pollution. And also the quality managing with the layers of grey shale/carbonaceous shale, stone bands, dirt bands etc in opencast coal mines has become a problematic work by the conventional method of mining.

All these issues have provoked the mining communal to look for a new method which is different from the conventional method so that the quality of production as well as the quantity of production increases as well as meeting the requirement of being environmentally safe operations. And this is the reason behind making of 'Wirtgen Surface Miner' and it was introduced first at Lakhanpur Opencast Project of Mahanadi Coalfields Limited, in Orissa on 21st June, 1999. It was happening for the first time in the history of coal mining Industry in India.

From soft rock continuous mining by the bucket wheel excavators, the current state-of-art of opencast mining technology has been shifted towards mining of harder materials like coal, gypsum, limestone etc. by the recently developed continuous surface miners.

These highly powered continuous surface miners not only give continuity of operation in hard rock mining but also can be used for selective mining of thin seams , for loosening of consolidated layers , being a supporting equipment for the bucket wheel excavator ; where ripping is impracticable due to high material strength and where blasting operation is prohibited etc.

The most important feature of the machine is the complete elimination of drilling, blasting, or ripping. The Continuous Surface Miner (CSM) is a continuously operating mining equipment , where with the help of a rotating roll the rock crushed frasend. The roll comes in addition to the crushing often the function of the load on a conveyor.

Surface miners are specialized mining methods that are often used where drilling and blasting is not possible or when drill is to be mined matches the requirements. The machines do not require drill or blast or subsequent crushing as the cutting drums break and size rock. These machines can load into conveyor belts or directly load into trucks.

CHAPTER-2

LITERATURE REVIEW

General description of surface miners

Use of surface miner

Application of surface miner

Comparison of surface miner with conventional mining method

Factors affecting suitability and productivity of surface miner

Cuttability classification for surface miners

Case studies and results (find out the mine where it has the max. suitability)

General description of surface miners:

Mainly there are three kinds of surface miners available on market today:

- Machine with middle drum configuration
- Machine with front cutting boom
- Machine with front cutting wheel

❖ Machine with middle drum configuration:

Its cutting width varies from 250-4200mm, weight 40-90tonn, and installed power 450-1250KW. Their manufacturing companies are Wirtgen, Bitelli, Huron. Now all over India and the world, only the "machine with middle drum type configuration" is used because the cutting drum is situated under the Centre of the machine and in between the length of crawler track. Four crawler tracks are situated, two at the front and two at the rear so that the big machine can resist its balance.

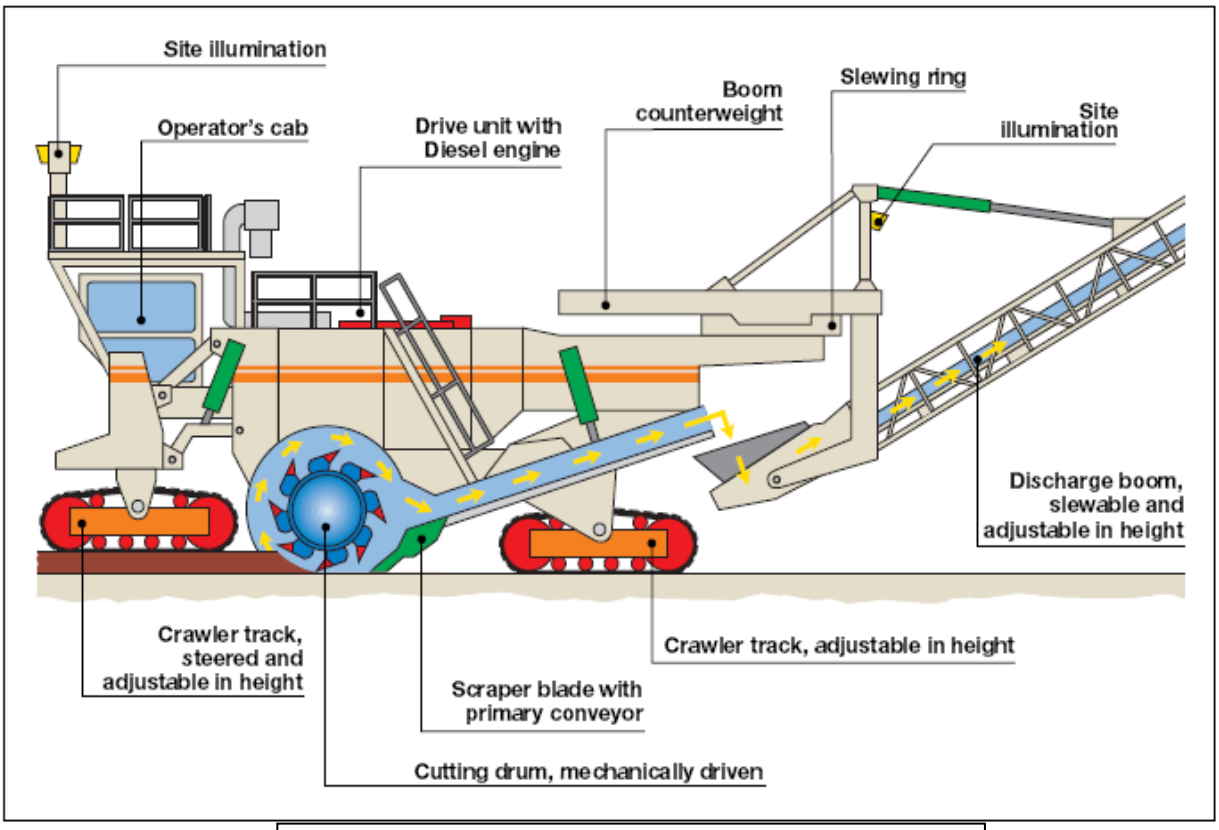

Fig-2.1 Machine with middle drum configuration

❖ Machine with front cutting boom:

From application point of view this machine is as important as other two. Its cutting width is 5250mm, cutting depth 1000 to 5500mm; weight 135tonn, installed power is 750 kw. Its manufacturing company is voest alpin. Earlier these type surface miners were used but not it has been stopped because the big cutting drum is situated at the front side of the machine and the machine has also a very big cutting boom attached for loading the material and this machine has only two crawler tracks. So the machine can't maintain the balance properly.

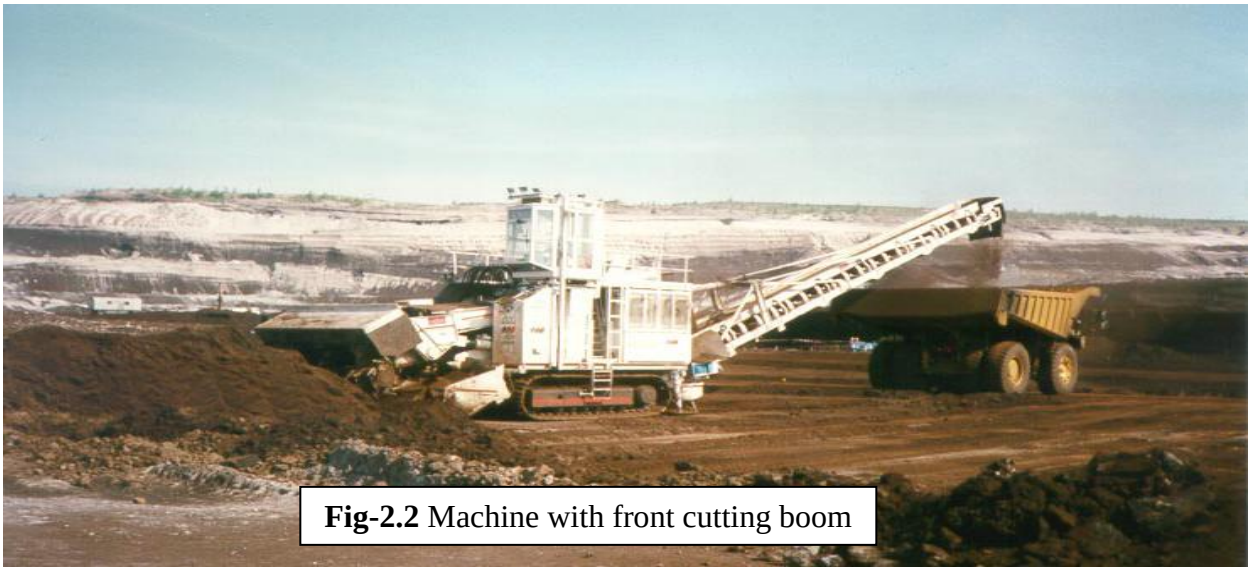

Fig-2.2 Machine with front cutting boom

❖ Machine with front cutting wheel:

The application of this type surface miner offers advantages whenever the following conditions have to meet:

- Mining of huge masses
- Selective mining of changing rock layers with thickness exceeding 0.5 m
- Selective with a high separation accuracy
- Manufacture of the lump masses appropriate for belt conveying with less fines
- Use of cost beneficial belt conveyor

This type surface miner was also used earlier but now it has been stopped because this machine contains a giant like cutting wheel which is situated on the front side of the machine and this machine consists of only three crawler tracks, two at the front and one at the rear. As a result the machine cannot resist its balance or stability throughout the operation.

Fig-2.3 Machine with front cutting wheel

PARAMETERS	TYPE OF SURFACE MINER		
	Middle Drum	Front Cutting Boom	Front Cutting Wheel
Cutting width (mm)	250-4200	5250	7100
Cutting depth/height (mm)	0-800	1000-5500	0-2900
Capacity	For all machines output is related to material characteristics		
Weight (t)	40-190	135	540
Installed power (kW)	450-1200	750	up to 3340
Manufacturers	Wirtgen, Bitelli, L&T and Huron	Vermeer, Tesmec, Voest Alpine	Krupp Fördertechnik & Tenova TAKRAF

Table-2.1

Here, I can conclude by overviewing the above three type surface miners, that the first one i.e "the machine with middle drum configuration" is more suitable in comparison with the other two because it is more efficient and sophisticated and also very safe.

Uses and Application of Surface miner:

This shows, for what other purposes the surface miner is suitable or applicable and its use in different operations. This shows versatility in suitability of surface miner.

- Desired materials:

We all know that the most common finish product is a selected material which is cut, crushed, loaded and hauled in a single method. Using the surface mining process, we can attain greater output also with fewer budgets and fewer apparatus. Also under this concept, we can mine the coal securely without any environmental problems.

- Clean usable surfaces:

Clean and steady surfaces are extra advantage of surface mining technology. A number of clients have used surface miners for entries to their mining or construction processes. This modest facility permits safe hauling and also avoids harm to other apparatus used in daily mining condition as well as construction conditions.

- Ramps:

Ramps which are desired for road and highway construction are other examples of complete yields of surface mining since the machineries operation can be programmed and GPS navigation can be added, optionally laser guided and the surface miner can make accurate fixed cuts or variable cuts to come across custom engineering requirements.

- Highwalls:

The surface miner is also capable of producing compact highwalls. The conventional mining approaches like drilling and blasting can loosen material on highwalls. But highwalls created by surface miners are steady, accurate and clean. There is no danger of falling substantial into the roadway. A safe working environment next to highwalls can be occupied by the surface miner.

❖ Trenching:

One major example of complete products is trenching. Trenching roads and under- passes are very time taking and costly. But the surface miner gives a clean, flat and steady surface on time and also within the budget, which a conventional mining method cannot achieve.

Fig-2.4 trenching by surface miner

Application of surface miner:

- Mining of harder minerals(ex: limestone, dolomite, gypsum, etc)
- Mining of thin seam deposits.
- Selective mining of materials with varying mineral content.
- Creating channels.
- Digging exploratory channel.
- Removal of partings
- Mining of residual minerals.
- Removal of consolidated overburden layer.
- Digging drainage ditches.

Comparison of surface miner with conventional mining method:

Why surface miner is suitable:

Here I have compared the surface miner with the conventional mining method to find out why surface miner is more suitable.

Mining by surface miner	**Conventional system of mining**
1.Cost of production is much lesser than conventional system e.g. in Belpahar OCP cost of production/tonee=Rs35	Cost of production is comparatively higher e.g. in Belpahar OCP cost of production/tonne =Rs 64.75
2. Requirement of drilling, blasting and crushing is not here.	Requirement of drilling, blasting and crushing.
3. Mining is possible in close proximity of village, road and other permanent structure.	Mining is not possible due to restriction in blasting.
4. No chance of spontaneous heating and fire.	Blasting produces crack in the coal bench which leads to spontaneous heating and fire.
5. Stability of bench and high wall is comparatively much better.	Stability of benches and high wall is comparatively poor due to induced stress caused by blasting.
6. It is an environmentally friendly method of mining.	Drilling, blasting and crushing produces adverse effect on environment.
7. Selective mining is possible as a result quality of mined out coal is better.	Selective mining is not possible.
8. Thin seam mining is possible as a result non-workable seam becomes workable.	Thin seam mining is not possible.
9. Less capital investment and infrastructure is required.	High capital investment and infrastructure is required.
10. Top of bench and high wall is smooth	Top of bench and high wall is uneven.

Table 2.2

Factors affecting productivity of surface miner:

According to the cuttability index, there are mainly five parameters which affects the suitability and the productivity of the surface miner and they are:

- **Point load index**

  Point load index is an index which determines the strength of hard rock materials and point load index is being influenced by sample size.

- **Volumetric joint count**

  Volumetric joint count can be defined as the sum of the number of joints per meter for each set present, and it is measured along the joint set perpendicular.

- **Abrasivity**

  If the Abrasivity increases then the performance of surface miner decreases so it is not suitable to use surface miner in this condition.

- **Cuttability**

  The overall performance of the surface miner mainly depends on cuttability index, if in any cases the cuttability index increases, then the performance of surface miner decreases. And also, if the cuttability index surpasses greater than 80, then at those conditions surface miner should not be positioned.

- **Machine Configuration**

  The performance of a surface miner depends on the machine configurations such as engine power, nature of coolant for tips, cutting tool configuration, drum weight and drum width,.

Cuttability classification for surface miners:

Among the 400 surface miners working over the world, more than 100 are working in Indian coal and limestone mines. Though surface miner was introduced as a technology to avoid the difficulties of blasting near the inhabitancy, but it became a cost-effective surface mining system. To reduce the cost of mining by surface miner, judicial planning and its proper implementations are essentially required. Deployment of surface miner in any surface mine requires three decisions to be made:

i) Check whether the mine is suitable or appropriate for positioning surface miner or not?

ii) If it is suitable, then which model of surface miner should be used to attain optimal production?

iii) And how the designated model can be sensibly positioned in the surface mine?

In the first and the second case, the decisions are taken by the mine planner and top management, whereas the third decision is the responsibility of the field engineers.

Performance of surface miner depends largely on the operating mode in which surface miner has to work and the cuttability index of the rock or material. Thus, it becomes a critical decision for the mine planner to adopt a suitable surface miner. Once the most suitable miner is decided, then it becomes a challenge for the field engineer to utilise the machine in appropriate operating mode. To solve these problems, cuttability index was being developed by Dey and Ghosh.

Then a fresh rockmass classification method is simply established by considering all those important parameters which influences such as, volumetric joint count and point load strength index. Direction of machine operation with respect to joint direction and impact of rock abrasivity are also been considered. Since the high power machine can cut a comparatively stronger rock, that is why the engine power of the cutting machine is also rated in this classification. The ratings of these parameters have been showed in the next page in a tabular form.

Class	I	II	III	IV	V
Point load index (I_s50)	< 0.5	0.5 – 1.5	1.5 – 2.0	2.0 – 3.5	> 3.5
Rating (I_s)	5	10	15	20	25
Volumetric joint count (no/m^3)	> 30	30– 10	10 – 3	3 – 1	1
Rating (J_v)	5	10	15	20	25
Abrasivity	< 0.5	0.5 – 1.0	1.0 – 2.0	2.0 – 3.0	> 3.0
Rating (A_w)	3	6	9	12	15
Direction of cutting respect to major joint direction	72^0 - 90^0	54^0 - 72^0	36^0 - 54^0	18^0 - 36^0	0^0 - 18^0
Rating (J_s)	3	6	9	12	15
Machine power (kW)	> 1000	800 – 1000	600 – 800	400 – 600	< 400
Rating (M)	4	8	12	16	20

Table 2.23rating of parameters which influences surface miner

Thus, the rock mass cuttability classification or the cuttability index (*CI*) is the sum of the rating of above five parameters.

Cuttability index (CI) = Is+Jv+Aw+Js+M

Based on this cuttability classification, the ease of excavation of rock mass using surface miner can be classified as given below:

Excavatability index	Possibility of ripping
$50 > CI$	Very easy excavation
$50 < CI < 60$	Easy excavation
$60 < CI < 70$	Economic excavation
$70 < CI < 80$	Difficult excavation, may be not economic
$CI > 80$	Surface miner should not be deployed

Table 2.4 effect of CI on surface miner

Production rate of a surface miner can be estimated as follow –

$$L^* = \left(1 - \frac{CI}{100}\right) kM_c \qquad (2)$$

where,

L^* = production or cutting performance (bcm/h),

M_c = rated capacity of the machine (bcm/h),

CI = cuttability index ,

k = a factor for consideration of influence of specific cutting condition and is a function of pick lacing (array), pick shape, atmospheric condition etc. and varies from 0.5 – 1.0.

The rockmass cuttability classification provides a handy tool for decision making on the applicability and selection of surface miners. The classification also gives a first hand idea about the "GO – NO GO" criterion on applicability of surface miner apart from an estimated performance.

Case Studies:

For my project work, I have visited to four different coal mines of MCL where surface miner is being used and from there I have collected information related to surface miner to compare which mine has the maximum suitability for utilizing the surface miner. I evaluate the suitability on the basis of cuttability index. The data is given below:

- Basundhara OCP:

Point load index = 1.2 i.e. rating Is = 10

Surface Miner used == 2200 SM

Rated machine capacity = 300 m3/h

Machine power = 596.5 kW i.e. rating M = 16

Volumetric joint count = 28 i.e. rating Jv = 10

Abrasivity = 0.6 i.e. rating Aw = 6

Direction of machine operation with respect to joint plane = 90◦ i.e. rating Js = 3

Thus, cuttability index (CI) = Is+Jv+Aw+Js+M = 45 (thus very easy cutting condition for surface miner)

Expected production (for k = 0.6) = (1 – 45/100) × 300 × 0.6 = 99 m3/h

Density = 1.4

Expected production achieved = 138.6 t/h

- Lakhanpur OCP:

Point load index = 1.1 i.e. rating Is = 10

Surface Miner used == 2100 SM

Rated machine capacity = 400 m3/h

Machine power = 448 kW i.e. rating Mc = 16

Volumetric joint count = 32 i.e. rating Jv = 5

Abrasivity = 0.4 i.e. rating Aw = 3

Direction of machine operation with respect to joint plane = 80◦ i.e. rating Js = 3

Thus, cuttability index (CI) = Is+Jv+Aw+Js+M = 37 (thus very easy cutting condition for surface miner)

Expected production (for k = 0.6) = (1 – 37/100) × 400 × 0.6 = 151 m3/h

Density = 1.4

Expected production achieved = 210 t/h

- Samleswari OCP:

Point load index = 1.0 i.e. rating Is = 10

Surface Miner used = 2200 SM

Rated machine capacity = 435m3/h

Machine power = 595 kW i.e. rating M = 16

Volumetric joint count = 35 i.e. rating Jv = 5

Abrasivity = 0.4 i.e. rating Aw = 3

Direction of machine operation with respect to joint plane = 80◦ i.e. rating Js = 3

Thus, cuttability index (CI) = Is+Jv+Aw+Js+M = 37 (thus very easy cutting condition for surface miner)

Expected production (for k = 0.6) = (1 – 37/100) × 435 × 0.6 = 164.45 m3/h

Density = 1.4

Expected production achieved = 229.6 t/h

- Belpahar OCP:

Monthly surface miner performance report:

September 2012:

Sl no.	Equipment make & model	O.E.M no.	CIL no.	Date of comm.	W/H	Prog. HR	Fuel sys.	Stg sys.	Elect sys.	Mech sys.	Hyd. sys.	Under carr.
1	Surface miner wirtgen-2200	439	EXC 2617	31.07. 09	370	16483		2			7	
2	Surface miner L & T-303 .	015			373	3690	3		38	5	31	5
			Total=743									

Table 2.5

Sl no.	Equipment make & model	OTH	Total b/d hrs	Total idle hrs.	Maint. Hrs.	Shift hrs.	absolute		Last year	
							%avl	% utl	%avl	% utl
1	Surface miner wirtgen-2200		9	251	40	670	93	55		
2	Surface miner L & T-303 .	5	37	230	30	670	90	56		
			46	481	70	1340	91	55	86	63

Table 2.6

This year prog.-743

Last year prog.-722

October 2012:

Sl no.	Equipment make & model	O.E.M no.	CIL no.	Date of comm.	W/H	Prog. HR	Gear box.	Stg sys.	Elect sys.	Mech sys.	Hyd. sys.	Under carr.
1	Surface miner wirtgen-2200	439	EXC 2617	31.07.09	141	16624		2		396	2	6
2	Surface miner L & T-303	015			266	3956	17		47	21	3	
			Total=407									

Table 2.7

Sl no.	Equipment make & model	OTH	Total b/d hrs	Total idle hrs.	Maint. Hrs.	Shift hrs.	absolute		Last year	
							%avl	% utl	%avl	% utl
1	Surface miner wirtgen-2200		340	149	20	650	45	22		
2	Surface miner L & T-303	2	143.5	212	28.5	650	74	41		
			483.5	361	48.5	1300	59	31	77	49

Table 2.8

This year prog.-1150

Last year prog.-1040

November 2012:

Sl no.	Equipment make & model	O.E.M no.	CIL no.	Date of comm.	W/H	Prog. HR	Gear box.	Stg sys.	Elect sys.	Mech sys.	Hyd. sys.	Under carr.
1	Surface miner wirtgen-2200	439	EXC 2617	31.07. 09	386	17010	4		4	3	2	3
2	Surface miner L & T-303 .	015		18.02. 11	309	4265	6			13		48.5
			Total=695									

Table 2.9

Sl no.	Equipment make & model	OTH	Total b/d hrs	Total idle hrs.	Maint. Hrs.	Shift hrs.	absolute		Last year	
							%avl	% utl	%avl	% utl
1	Surface miner wirtgen-2200		10	213	60.5	670	89	58		
2	Surface miner L & T-303 .		42.5	294	24.5	670	90	46		
			52.5	507.5	85	1340	90	52	88	60

Table 2.10

This year prog.-1845

Last year prog.-1440

Result from the case studies:

From these above four case studies, I have found that all the four mines have different amount of cuttability index. As we all know, if the cuttability index increases then the performance of surface miner decreases. Here the cuttability index is highest at Basundhara OCP and lowest at Samleswari OCP. As the cuttability index is lowest in the Samleswari OCP, the production in this mine is higher than the other two mines. Similarly the production is less in Basundhara OCP in comparison with the other two because here the cuttability index is more.

So here, I can conclude that Samleswari Opencast Project has the highest suitability of utilizing the surface miner.

Details about the surface miners used in the above mines:

Sl no.	Name of mine	No. of SM used	Company name	model	Production achieved M^3/hr
1	Samleswari OCP	2	Wirtgen	2200SM	200
			L & T	KSM304	750
2	Belpahar OCP	2	Wirtgen	2200SM	195
			L & T	KSM303	700
3	Lakhanpur OCP	1	Wirtgen	2100SM	110
4	Basundhara OCP	1	Wirtgen	2200SM	200

Table 2.11

Wirtgen Surface Miners:

Fig-2.5 Writgen 2200SM which is used in samleswari, belpahar & basundhara OCP

Name of company	Wirtgen			
Model	2200SM	2500SM	3700SM	4200SM
Cutting width (m)	2.20	2.50	3.70	4.20
Cutting depth (m)	0.35	0.60	0.60	0.80
Drum diameter (m)	1.14	1.40	1.40	1.86
Fuel consumption (L/h)	150	191.5	284	284
Operating speed (m/min)		0–25	0–20	0–20
Travel speed (km/min)	0–5	0–3.9	0–2.5	0–2.5
Engine (HP)	800	1050	1600	1600
Weight (t)	51.0	103.0	176.0	191.4
No. of tools	76	Depends on	Depends on	Depends on
Spacing (mm)	38	application	application	application
Cutting drum drive	Mechanical			
Number of tracks	4			
Track drive system	Hydraulic			
Drum speed (r/min)	60–100			

Table 2.12

Machine Details of 2100 SM and 2200 SM :

Surface Miner 2100 SM:

	Surface Miner 2100 SM
Milling width, max. mm	2,000
Milling depth mm	0-240
Milling drum :	
Tool spacing mm	35
Number of cutting tools	76
Drum diameter with tools mm	1,050
Drum diameter without tools mm	710
Drum tilt, max. o(degree)	8
Engine:	
Manufacturer	Mercedes-Benz
Type	OM 444 LA
Cooling system	Water
Number of Cylinders	12
Output kW/HP/PS	448/ 601 / 610
Speed rpm	2,100
Displacement cm3	21,930
Fuel consumption full load |/h	110
Fuel consumption 2/3 –load |/h	80
Operational characteristics:	
Operating speed rang m/min	0 – 27
Travel speed range km/h	0 – 4.6
Theor, gradeability,travel gear %	16
Theor,gadeability, operating gear %	47
Ground clearance mm	350
Weights:	
Axle load, front daN (kg)	18,600
Axle load, rear daN (kg)	18,400
Shipping weight daN (kg)	37,000
Operating weight, CE daN (kg)	40,500
Track units:	
Tracks, front mm	2,077 x 350 x 710
Tracks, rear mm	2,077 x 350 x 710
Tank capacities:	
Fuel tank l	1,200
Hydraulic oil tank l	300
Water tank l	4,180
Electrical system V	24
Conveyor System:	
Primary belt width mm	1,000
Discharge belt width mm	1,000
Theoretical belt capacity m3/h	550
Shipping dimensions:	
Machine L x W x H mm	8,830 x 2,600 x 3,000
Conveyor L x W x H mm	8,000 x 1,150 x 1,500

Table-2.13

Surface Miner 2200 SM:

	Surface Miner 2200 SM
Milling width, max. mm	2,200
Milling depth mm	0-300, 0-250
Milling drum :	
Tool spacing mm	38
Number of cutting tools	76
Drum diameter with tools mm	1,115
Drum diameter without tools mm	
Drum tilt, max. o(degree)	5
Engine:	
Manufacturer	Caterpillar
Type	C27ATAAC
Cooling system	Water
Number of Cylinders	12
Output kW/HP/PS	708/ 950/ 963
Speed rpm	2,100
Displacement cm3	27,000
Fuel consumption full load |/h	187
Fuel consumption 2/3 –load |/h	125
Operational characteristics:	
Operating speed rang m/min	0 – 84
Travel speed range km/h	0 – 5
Theor, gradeability,travel gear %	90
Theor,gadeability, operating gear %	90
Ground clearance mm	370
Weights:	
Axle load, front daN (kg)	25,430-26,105
Axle load, rear daN (kg)	25,350-26,025
Own weight daN (kg)	44,500-45,850
Operating weight, CE daN (kg)	47,730-49,080
Track units:	
Tracks, front mm	2,200 x 370 x 790
Tracks, rear mm	2,200 x 370 x 790
Tank capacities:	
Fuel tank l	1,400
Hydraulic oil tank l	500
Water tank l	5,000
Electrical system V	24
Conveyor System:	
Primary belt width mm	1,100
Discharge belt width mm	1,100
Theoretical belt capacity m3/h	668
Shipping dimensions:	
Machine L x W x H mm	9,700 x 2,800 x 3,000
Conveyor L x W x H mm	8,700 x 1,700 x 1,300

Table-2.14

L & T surface miners:

Fig-2.6 KSM303 surface miner used in Belpahar OCP

Fig-2.7 KSM304 surface miner used in Smleswari OCP

Specification of L & T surface miners:

Model no	Drum width(m)	Machine power (kw)	Operating weight (ton)	Rated capacity (m3/h)	Maximum cutting depth (mm)	Maximum cutting speed (m/min)	Operating gradient (1 in %)
KSM303	3.0	800	100	NA	350	15	5
KSM304	3.0	895	100	NA	400	20	5

Table-2.15

CHAPTER-3

Development of a Computer Program Using C for comparing the suitability of surface miner:

Theoretically the quantity of mineral cut by surface miner can be estimated by the following formula

$Q= Vm*h*b*60m^3/h$

Where

Q= Quantity cut, m^3/h

Vm= Machine speed, m/h

H= Milling depth, m

B= Milling drum width, m

Here I have found another way to estimate the suitability of surface miner among these four mines by the help of C programming. Now by using the above formula in C programming I will show the mine that has the maximum suitability of having surface miner.

Program Code:

```
#include <stdio.h>
#include <stdlib.h>
int main(void)
{
float v,h,b;
float quantity;
printf("\nEnter Machine Speed in m/h\n");
scanf("%f", &v);
printf("\nEnter Milling Depth in m\n");
scanf("%f", &h);
printf("\nEnter Milling Drum Width in m\n");
scanf("%f", &b);
quantity=v*h*b*60;
printf("\nQuantity Cut = %f m3/h", quantity);
getch();
}
```

Output:

Samleswari OCP

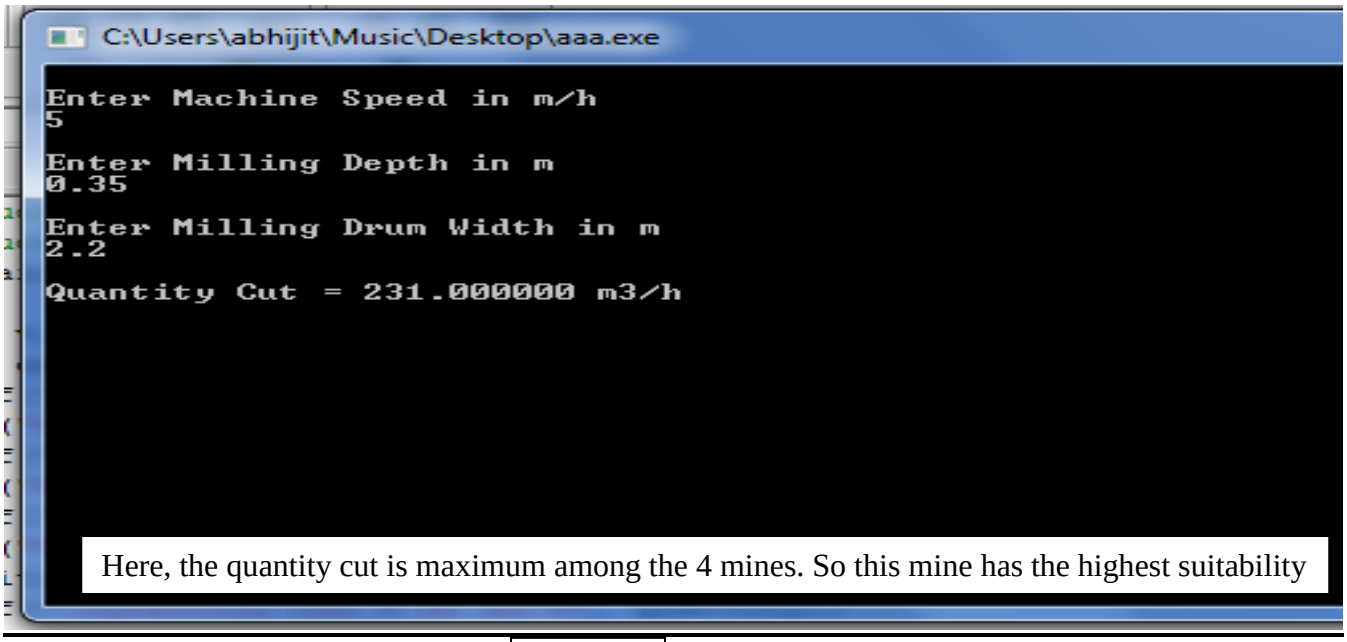

Fig-2.8

Belpahar OCP

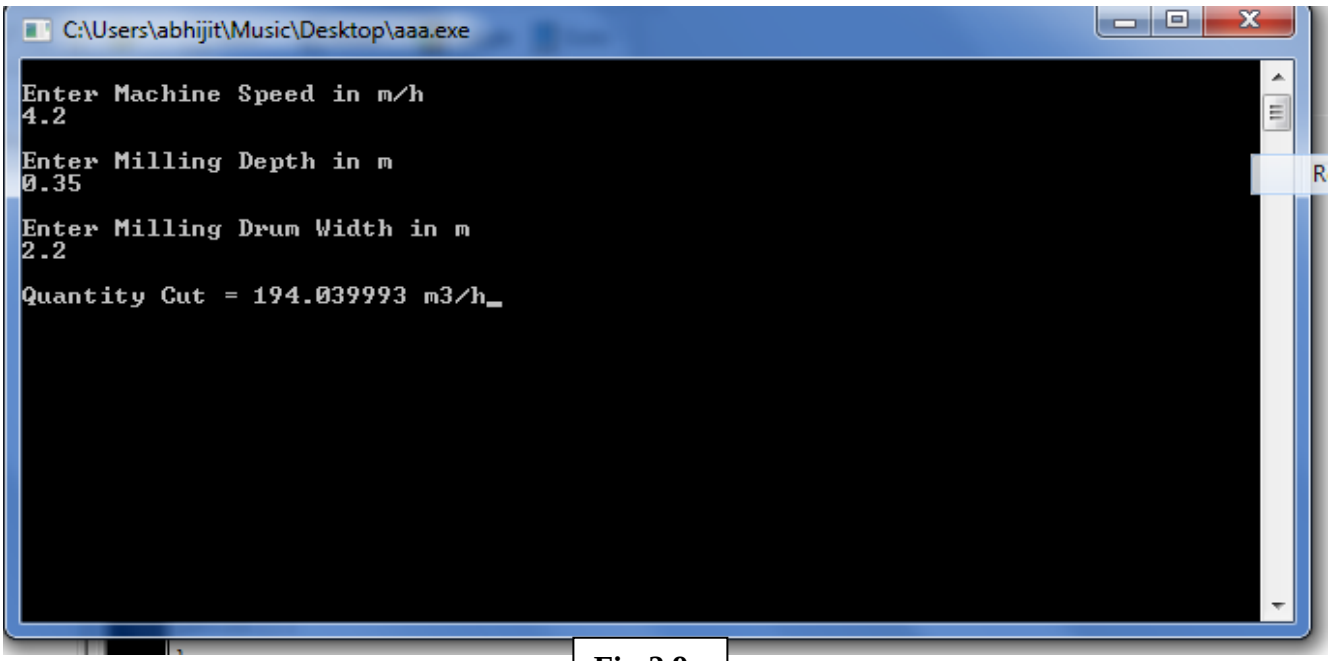

Fig-2.9

Lakhanpur OCP

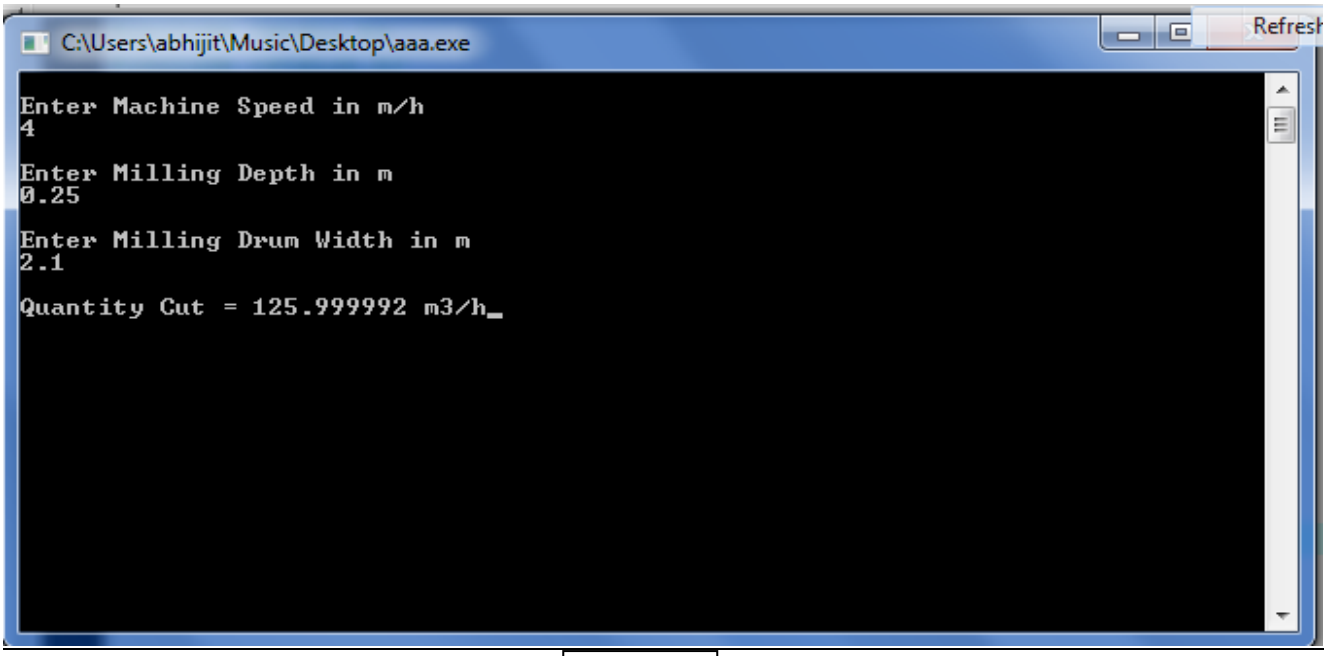

Fig-2.10

Basundhara OCP

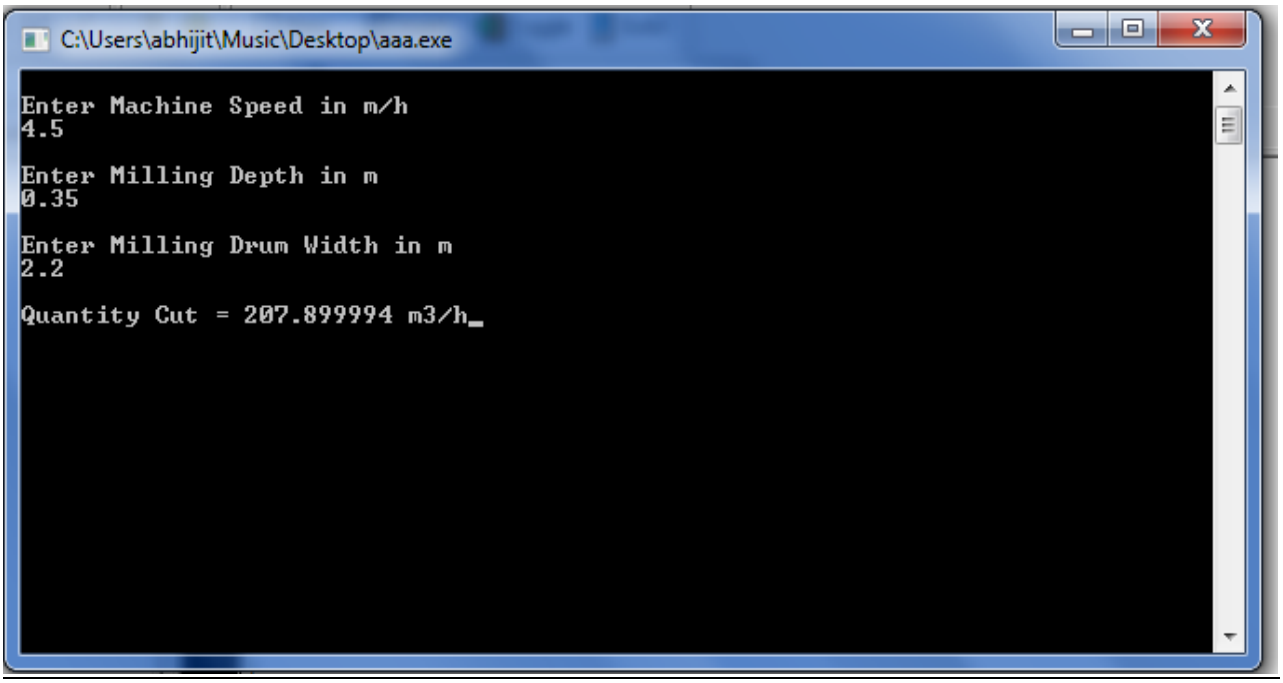

Fig-2.11

CHAPTER-4

Safety of surface miner

Advantage of surface miner

The reason of applicable of surface miner or the suitability of surface miner also depends upon some other parameters like:

Safety of surface miner:

There is no fire hazard to the coal seam as it never leaves behindhand any free material or loose material responsive to spontaneous heating. The road converts very smooth after every cut and thus enables easy movement of the tippers and other apparatus.

The important safety structures or features of the surface miner are:

- There are five numbers of engine kill switches present, one in the control panel and other four on the four crawler tracks of surface miner.
- There is a scraper door limit switch exists and If the scraper door is lifted, then drum drive, conveyor drive and advance drive will be cut off.
- There is also a milling drum side plate warning light situated and if the side plate is lifted any time then the red warning light will start blinking for attention of the operator.
- Reverse motion warning horn.
- The discharge conveyor slewing process becomes cut off when the windrowing action begins. The conveyor slewing can be made cut off for marching or conveyance for an extended distance.
- There are also four warning horn switches present, one in the control panel, and other four on the four crawler tracks of surface miner.

Advantage of surface miner:

- It eliminates drilling, blasting, etc. which is very good on environmental point of view.
- Primary crushing of material is not needed and can be controlled by the optimum selection of the cutting drum.
- Till date material with an uniaxial compressive strength of 150Mpa can be economically mined by the latest developed surface miner.
- Thin coal seam or thin layer of ore body can extracted nicely and cleanly by the machine which yields which yield better quality ROM and due to this reason beneficiation cost is minimized.
- Since it is a self-mobile machine it is very flexible is operation. The single machine can be used in various sections of mine or many mines.
- It has a very large discharge radius and can load material on dumpers, belt conveyors , mobile conveyor, etc.
- With the help of automatic grade and slope control system correct slope for drainage and mining of dipped seam/ore is possible.

CHAPTER-5

Conclusion

Future scope of study

Conclusion:

The surface miner is multipurpose and beneficial apparatus which is capable of extracting the quality coal in extremely inter-banded seams. Collecting satisfactory material and data about the seam features, seam behavior and seam characteristics and by making careful planning of every cut of the surface miner joint with good supervision, we can reach upto the achievement of grade enhancement and grade control.

Disposition of a surface miner in a mine has a incredible possibility of savings of man power necessity. The surface miner also enables superior and intense area of regulation, since the apparatus population is decreased, consecutively guaranteeing greater production, increase efficiency of dump trucks due to greater fill factor on account of identical size.

The revolutionary trials have strengthened the confidence of the coal industry and also inspire the industry to go for greater capacity apparatus which is suitable for cutting the stiffer coal or harder coal as well as the dirt bands in other fields of India. By means of the state of art technology of surface miners attached with heavy ash investigation, opens up extensive views of additional potentials in surface mining particularly for quality improvement without falling back to coal beneficiation.

Now the new cuttability index can able to deliver a convenient tool for decision making on the matter of applicability of surface miners. This is a very good method for comparing different production materials of different mines.

Scope for future study:

In future, if we utilize the surface miner properly and deploy the new, modern and high capacity surface miners in our mines, then it also can be suitable for other mining operations such as:

Utilization of surface miner in making of haul road:

In some of the foreign countries, the surface miners are being used in the road construction work and it was known to be very much successful and economical there. The potentials of disposition of the surface miner in building of haul road in our Indian geo-mining conditions may also be studied for future application.

Working of surface miner with the help of electrical power:

In India, around 65 to 70 percent of petroleum and its products are being imported from the foreign countries each year due to low backup. This is also responsible for air pollution. The potentials of working surface miner with the help of electrical power may be studied in near future as a result the cost of production and carbon emission may be further reduced.

Utilization of surface miner in the extraction of over burden:

Now the surface miner is being used only for coal extraction and it is found to be very much environmental friendly and also economic. The crushing strength of the over burden in most of the coal field is found to be less than 120 M Pa. and it has been found that the 3700 SM, and 4200SM surface miner of Wirtgen make are capable to cut the rock upto 120 M Pa. So, the probability of placement of 3700 SM and 4200SM surface miner for over burden extraction may be studied for future application.

CHAPTER-6

REFERENCES

Reference**:**

1. Dey, K. and Sen, P. (2001), Selection of optimum mode of continuous surface miner operation- A methodology, The Indian Mining & Engg. Journal, May/June, pp.21-24.
2. Dey K., (1999), Performance Analysis of Continuous Surface Miner in Indian Surface Coal Mine – A case Study, Unpublished M. Tech Dissertation submitted to Indian School of Mines, Dhanbad, pp. 1 – 40.
3. Ghose A. K., 1996, Rockmass Classification – A Design Tool for Mining, Civil, Engineering and Construction Industry, Vol. 44, No. 2, February, pp.63 – 76.
4. www.wirtgen.de/media/.../pdf.../05_surface_miner/_.../jr_tunnelling_e.pdf
5. www.uea.com.au/.../24891802483460e989329d7c0554b329.p_4200sm_e....
6. www.wirtgen.de/media/.../pdf.../05_surface_miner/_...2/.../m_mining_e.pdf
7. Dey K. and Ghose A. K. (2008), Predicting "Cuttability" with Surface Miners – A Rockmass Classification Approach, Journal of Mines, Metals and Fuels, Vol.56 No.5 & 6 May – June, pp 85 - 92.
8. Ghose A. K., (2008), New Technology for Surface Mining in the 21st Century – Emerging Role for Surface Miner, Journal of Mines Metals and Fuels, Vol. 56 No. 3 & 4, March – April, pp. 41 – 43.
9. Materials taken from Samleswari OCP, Belpahar OCP, Lakhanpur OCP and Basundhara OCP.
10. http://www.slideshare.net/isnindian/surface-miner-11998161
11. http://www.takraf.com/en/products_services/opencastminig/surfaceminer.htm
12. Anon (2008). Surface miner manual of Wirtgen Gmbh: 2 -100.
13. Pradhan P, Dey K (2009). Productivity Improvement through Selection of Operating Mode of Surface Miner - A Computational Approach. National Seminar on Productivity improvement in surface mines and quarries – role of new technology and ancillary equipment. Kolkata. January 03-04.