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# *A New Cuttability Index for Performance Prediction of Continuous Miner*

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## ABSTRACT

Continuous miner is the latest technology used for enhanced production from underground coal mines. However, currently no reliable tools for the prediction of performance of continuous miner is available. The available cuttability indices are mainly developed for the prediction of performance of road headers. Currently the same are being used for the continuous miner also. However, road headers are mainly designed for hard rock excavation and thus their design and performance are quite different from the continuous minor.

In this research work, the existing cuttability indices for road headers are reviewed. In considerations of the same, the parameters influencing cutting performance of a machine is enumerated. The influencing parameters are divided into three categories, namely, rockmass parameters, machine parameters and application parameters. Field and laboratory experiments are carried out for generating a database for the rock properties, machine properties and application parameters. However, all the continuous miners monitored for the performance study are of similar model and thus, no variation observed in the machine parameters. Application parameters are also found same as the operating dimensions of the bord and pillar mining is found similar for all the cases. The dependency of individual parameters are established through regression analysis. The cuttability index is established through conditional multivariate analysis. The cuttability index developed is correlated with the performance observed and a model is proposed to estimate the production from the continuous miner. This model is strictly valid for the experimented machine and application parameters. The similar procedure may be used for developing similar model for the other machines.

***Keywords:*** Continuous miner; Cuttability index; Performance prediction; Rock mass classification

## 1. INTRODUCTION

The largest coal producing countries like China, USA and Australia are producing coal from underground mining with respect to their total production at 95%, 33% and 20% respectively (World Coal Association, 2014). India is ranked third in world coal production with just 6.74% share of coal production from UG mines as in the financial year 2016-17 (Mukerjee and Pahari, 2019). Due to the depletion of near surface deposits as well as non-availability of lands for surface mining, underground mining is being emphasized to cater country's coal demand. As the drilling and blasting methods of winning coal is cyclic in nature, it is difficult to achieve higher productivity (Sen et al., 2000). Therefore, the deployment of continuous coal winning machines namely, shearer, coal cutting machines, coal plough and continuous miner, is felt essential to increase the production rate from underground collieries in India. In the beginning of this millennium, efforts are made to search for applicability of these continuous coal-winning machines. In the year 2002, first time a continuous miner was deployed on experimental basis (Uday Kumar, 2015). After a run of almost two decades, the continuous miner is well accepted in coal mining sector due to its high production rate. However, it is essentially required to establish a technical understanding about the performance of continuous miner based on the geo-mining conditions. In this context, it is logical to establish a suitable cuttability index to predict the performance of continuous miner. In this paper, the existing cuttability indices are reviewed and a new cuttability index for continuous miner is proposed. A new relationship is also proposed to predict the output from continuous miners using the new cuttability index.

## 2. STATE OF THE ART

Development of continuous miner was initiated in 1870s and was continued to mark a new paradigm in mining system (Dey and Ghose, 2009). Continuous miner is basically a rock-cutting machine which cuts the rock on the rotation of its cutter head. Mechanized rock cutting enables the users to accelerate developmental excavation at reduced cost. However, selection of a mechanized rock cutting system must be guided through – (i) understanding of the characteristics of rockmass, (ii) required product characteristics (mainly, size and grade) and (iii) deployment of suitable equipment (especially, the excavating machine) (Dey, 1999). Thus, design consideration of a cutting system should have two basic elements – the machine and the rockmass (Dey and Ghose, 2011). Rockmass is a natural component in the earth's crust and hence immutable, while a machine is the product of human ingenuity and can be modified to suit a specific requirement (Eskikaya and Tuncdemir, 2007). Therefore deployment/selection of continuous miner depends on its interaction with the rock mass. The understanding of this cutter-rock interaction is termed as "Cuttability". "Cuttability" can be defined as the easiness to cut for a particular cutter-rock interaction. Thus, "Cuttability" of a continuous miner is influenced by (i) rock/rock mass parameters, (ii) machine parameters and (iii) the type of application, as given in Table 1.

Table 1- Parameters influencing cuttability (Dey and Ghosh, 2010)

| Rock/Rock mass Parameters | Machine Configuration | Type of Application |
|---|---|---|
| Moisture content, density, brittleness, unconfined compressive strength, point load index, Young's modulus, specific fracture energy, toughness index, tensile strength, sonic velocity, abrasivity, volumetric joint count, and stickiness of material | *Cutting tool configuration* - rake angle, attack angle, clearance angle and tip angle, pick lacing, type of pick number of picks, tip material, machine weight, engine power, and nature of coolant for tips | Direction of cutting, length, height and width of operating area, operator skill, specific requirements dry/wet, fragmentation desired and output |

A number of researchers proposed different rock mass classification approach to define cuttabaility of different excavation systems. Some of the notable rock mass classification systems are - discontinue strength classification (Franklin et. al., 1971), rippability rating chart (Weaver, 1975), excavation index (Kirsten, 1982), geological factors rating scale (Minty and Kearns, 1983), engineering classification of coal measures (Scoble and Moftuoglu, 1984), rippability chart (Singh et. al., 1986), excavatability index rating scheme (Hadjigeorgiou and Scoble, 1990), diggability index (Karpuz, 1990), revised excavatability graph (Pettifer and Fookes, 1994),and cuttability index (Dey and Ghose, 2008).

Continuous miner is a machine, which utilized a cutter head mounted on a boom and fitted with a number of point attack picks. This machine is resembled to the road header, a common machine used for rock excavation in hard rock tunnels. Therefore, a detailed review of the cuttability indices for Roadheader is as follows:

Based on the rock toughness and power, a performance prediction model was proposed for DOSCO-III roadheader deployed in coal measure rocks as shown in Figure 1 (Farmer, 1980).
Farmer (1980) defined rock toughness as –

$$RT = \frac{\sigma_c^{\ 2}}{E} = \frac{N\ \eta}{L^*} \qquad (1)$$

where

$RT$ = rock toughness (MPa),
$N$ = power (kW),
$\eta$ = efficiency,
$L^*$ = production (bcm/h),
$E$ = Young's modulus (GPa), and
$\sigma_c$ = unconfined compressive strength (MPa).

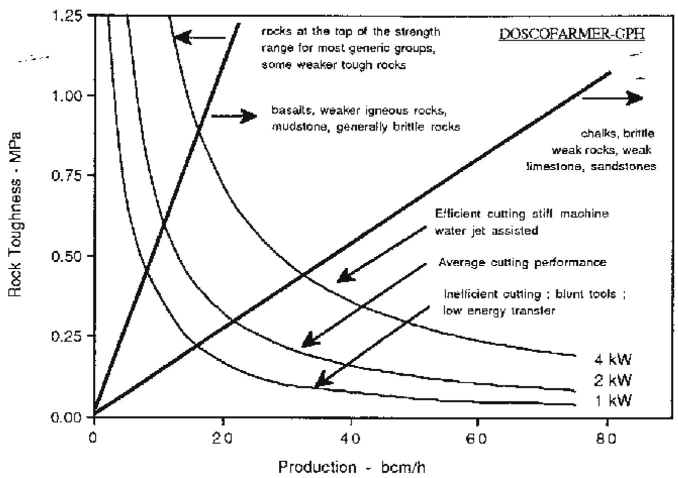


Figure 1 – Relationship between production and rock toughness (Farmer, 1986)

Roxborough (1987) developed a laboratory based core cutting test setup to estimate specific energy of cutting test and proposed a selection criterion for heavy and medium weight road headers (Table 2).

Table 2 - Selection of roadheader based on specific energy test (Roxborough, 1987)

| Upper value of laboratory specific energy ($MJ/m^3$) | | Generalized cutting performance |
|---|---|---|
| Heavy weight machine | Medium weight machine | |
| 25 – 32 | 15 – 20 | Machine can cut economically, if occurs in thin bed (< 0.3 m) |
| 20 – 25 | 12 – 15 | Poor cutting performance<br>Point attack tool may be more beneficial and low speed cutting motor will improve stability. |
| 17 – 20 | 8 – 12 | Moderate to poor performance<br>For abrasive rocks frequent pick change is required. |
| 8 – 17 | 5 – 8 | Moderate to good cutting performance with low machine wear |
| < 8 | < 5 | High advance rate and high productivity |

Bilgin et al. (1988) proposed a rock mass cuttability index (RMCI) using UCS and rock quality designation (RQD) as –

$$RMCI = \sigma_c \left( \frac{RQD}{100} \right)^{2/3} \tag{2}$$

where

$RMCI$ = rock mass cuttability index ($kg/cm^2$),
$RQD$ = rock quality designation (%), and
$\sigma_c$ = unconfined compressive strength ($kg/cm^2$).

A statistical correlation was established between the instantaneous cutting rate (in bcm/hr) of a roadheader with RMCI and motor power of the machine as given below:

$$ICR = 0.28 \times P \times 0.974^{\boldsymbol{RMCI}} \tag{3}$$

where

P = motor power (HP), and
ICR = Instantaneous cutting rate (bcm/h).

The performance of a roadheader was defined by Gehring (1989) as –

$$L^* = \frac{k}{\sigma_c} N \tag{4}$$

where

$L^*$ = production or cutting performance (bcm/h),
$N$ = cutter head power (kW),
$k$ = a factor for consideration of relative cuttability or tuning effect between road header and rock, and
$\sigma_c$ = unconfined compressive strength (MPa).

Further, Gehring (1989) established a relationship between ICR and rock uniaxial compressive strength (UCS) for a milling type roadheader with 230kW cutter head power and an Alpine Miner (AM-100) ripping type roadheader with 250kW cutter head power(Kirsten, 1982; Minty and Keams, 1983; Pettifer and Fooks, 1994; Ebrahimabadi et al., 2011) as given below:

$$ICR = \frac{719}{C^{0.78}} \quad \text{(for ripping type roadheaders)} \tag{5}$$

$$ICR = \frac{1739}{C^{1.13}} \quad \text{(for milling type roadheaders)} \tag{6}$$

where

$ICR$ = cutting performance ($bm^3/h$).
$C$ = uniaxial compressive strength (MPa), and

For a roadheader model VASM-2D; Gehring (1992)[25] modified the previous model as:

$$L^* = \frac{k_1 \times k_2 \times k_3}{\sigma_c} N \tag{7}$$

where

$k_1$ = relative cuttability of intact rock and,
= 6 for very tough and plastic rock,
= 7 for tough and plastic rock,
= 8 for average rock,
= 9 for brittle rock,
= 10 for very brittle rock, and
= 10 – 15 for coal,
$k_2$ = influence of discontinuity such as joint, bedding plane etc.
= 1 for massive and discontinuity distance > 25 cm,
= 1.5 – 2 for layered/fissured, thinner bed rock, discontinuity 10 – 25 cm, and
= 2.5 for layered/fissured/interbedded rock discontinuity <5 cm.
$k_3$ = influence of specific cutting condition and is a function of no sumping, cutting height, cuter head oscillation, pick array, pick shape. However, for roadheaders, its value ranged from 3.5 – 4.5.

Rostami et al. (1994) adopted the full-scale linear cutting tests in optimum conditions using real life cutters to obtain the specific energy value. The accepted correlation was established between ICR with power of the machine, specific energy (Hedjigeorgiu and Scoble,1990; Karpuz, 1990; Pettifer and Fookes, 1994; Ebrahimabadi et al., 2011). Rostami et al. (1994) also pointed out that 'k' value was changed in the ranges of 0.45 - 0.55 and 0.85 - 0.90 for roadheaders and TBMs respectively.

$$ICR = k \times \frac{P}{SEopt} \tag{8}$$

where

ICR = instantaneous cutting rate ($m^3$/h),
$SE_{opt}$ = optimum specific energy (kWh/$m^3$), and
k = energy transfer co-efficient of mechanical miner utilized.

Copur et al. (1997, 1998) relates cutting rate with UCS based on available field performance data for different types of roadheaders at different geological conditions. They stated that if power and weight of roadheaders were considered together, in addition to UCS, the cutting rate predictions would be more realistic. The predictive equations for transverse roadheaders are proposed as follows:

$$RPI = (P \times W)/UCS \quad (9)$$
$$ICR = 27.511 \times e^{0.0023 \times RPI} \quad (10)$$

where

ICR = instantaneous cutting rate ($m^3$/hr)
RPI = roadheader penetration index,
W = roadheader weight (tonne),
P = Cutter head power (kw), and
UCS = uniaxial compressive strength (MPa).

Ebrahimabadi et al.(2011) proposed rock mass brittleness index (RMBI) in-order to investigate the influence of intact and rock mass properties on roadheaders performance. Performance predictor model between instantaneous cutting rate (ICR) and RMBIwas established through regression analysis with $R^2$ value of 0.92 (Karpuz, 1990; Kirsten, 1982).The predictive equations are as follows:

$$RMBI = e^{(\sigma_c/\sigma_t)} \times (RQD/100)^3 \quad (11)$$
$$ICR = 30.75 \times (RMBI)^{0.23} \quad (12)$$

where

RMBI = rock mass brittleness index,
$\sigma_c$ = uniaxial compressive strength of rock (MPa),
$\sigma_t$ = Brazilian tensile strength of rock (MPa), and
*RQD* = rock quality designation of the rock mass (%).

Deployment of a machine depends on its performance prediction and expected economics. Till date no system is available for the performance prediction of continuous miner. Mine planners are using prediction formula available for the road header while deciding the application of continuous miner. From the above review, a host of parameters is found influencing the performance of a rock cutting machines similar to roadheader. Thus, some of these parameters are accepted to develop the prediction models for continuous miner. So, to observe the cutting performance of the continuous miner, it is decided to collect the data pertaining to rock, machine and application parameters from the mine as proposed by different researchers. Thus, the data measured in the field is the measured instantaneous cutting rate (MICR) and the data collection in the field includes the following parameters:

- Specifications of the Machine: Machine weight (W), cutter head power (P), bit type, size, shape, allocation of bits on the cutter head and capacity of the backup system.
- Rock and rock mass properties: UCS, BTS and RQD.

## 3. EXPERIMENTAL WORK

Field investigations are conducted at the continuous miner faces of Indian underground coal. The detailed specifications of the continuous miners are given in Table 3.

Table 3 - Specifications of the CAT continuous miners

| Specification | CAT-CM345 |
|---|---|
| Length, width and Height (m) | 11.2, 3.17 and 1.829 |
| Weight (tonne) | 74.8 |
| Cutter drum diameter (mm) | 1118 |
| Cutter-head power (kW/HP) | 372/500 |
| No. of picks | 66 |
| Rotating speed (rpm) | 45 |
| Max. mining height (m) | 4.623 |
| Min. mining height (m) | 2.337 |

Table 4 - Rock properties and measured instantaneous cutting rates for all cutting cases

| S.No. | UCS(MPa) | BTS(MPa) | RQD(%) | MICR(tonne/h) |
|---|---|---|---|---|
| 1 | 16.2 | 1.9 | 25 | 788.8 |
| 2 | 22.6 | 2.4 | 21 | 598.4 |
| 3 | 24.1 | 2.7 | 28 | 544 |
| 4 | 24.7 | 2.8 | 24 | 462.4 |
| 5 | 25.1 | 3.2 | 28 | 462.4 |
| 6 | 21.8 | 2.3 | 25 | 666.4 |
| 7 | 16.2 | 1.9 | 21 | 788.8 |
| 8 | 24.7 | 3.2 | 24 | 544 |
| 9 | 21.8 | 2.3 | 21 | 652.8 |
| 10 | 20.4 | 2.1 | 25 | 680 |
| 11 | 23.9 | 2.6 | 24 | 571.2 |
| 12 | 23.9 | 3.2 | 24 | 571.2 |
| 13 | 20.4 | 2.1 | 21 | 707.2 |
| 14 | 16.2 | 1.9 | 25 | 775.2 |
| 15 | 20.4 | 2.7 | 25 | 666.4 |
| 16 | 20.4 | 1.9 | 28 | 666.4 |
| 17 | 20.4 | 2.1 | 21 | 680 |
| 18 | 15.7 | 2.4 | 24 | 802.4 |
| 19 | 20.4 | 2.1 | 25 | 666.4 |

*Notations: UCS – uniaxial compressive strength; BTS – Brazilian tensile strength; MICR – measured instantaneous cutting rates*

Performance of the machine is observed for 19 different faces. The Instantaneous cutting rates measured for a machine having its cutter-head power (372kW) and weight (74.8 tonne) at different cutting cases with their properties at respective cutting rates, are shown in Table 4.

It can be seen from the Table 4, that in Jhanjra Colliery the continuous miner is subjected to operate in the coal with a variation in UCS ranging from 14.7MPa to 26.4MPa, in BTS ranging from 1.5MPa to 4.7MPa and with RQD ranging from 16% to 40%.

Onsite core drilling and corresponding determination of geotechnical properties in respect of UCS, BTS and RQD are carried out by the mine authority. The data pertaining to the same are presented in the Table 4.

After establishing the database the instantaneous cutting rates are calculated using relation given by different researchers. Different researchers have proposed a number of models to predict the instantaneous cutting rate of cutting machines (mostly roadheader). In-order to estimate the instantaneous cutting rates, it is required to calculate the respective indices as considered in the prediction of various researchers namely,Bilgin et, al. (Rock Mass Cuttability Index - RMCI), and Copur et, al. (Roadheader Penetration Index - RPI). The instantaneous cutting rates, for 19 different cases, are calculated based on the proposed models of Bilgin et.al. (1988), Gehring (1989) and Copur et al. (1997) and are named as BICR, GICR and CICR respectively (Table 5). Gehring's instantaneous cutting rate (GICR) is calculated directly from the Eqn. (1) using uniaxial compressive strength (UCS), Copur predicted instantaneous cutting rate (CICR) using roadheader penetration index (RPI) and given by Eqn. (5), Bilgin predicted instantaneous cutting rate (BICR) using the rock mass cuttability index (RMCI) and given by Eqn. (3). The expected production from these indices are given in Table 5.

Table 5 - RPI, RMCI, BICR, GICR and CICR calculated from respective Indices

| S.No. | MICR | RPI | RMCI | BICR | GICR | CICR |
|---|---|---|---|---|---|---|
| | (tonne/h) | | | (tonne/h) | (tonne/h) | (tonne/h) |
| 1 | 788.8 | 1717.6 | 6.43 | 118 | 82 | Outlier |
| 2 | 598.4 | 1231.2 | 7.98 | 113 | 63 | 467 |
| 3 | 544 | 1154.6 | 10.31 | 107 | 60 | 392 |
| 4 | 462.4 | 1126.5 | 9.54 | 109 | 59 | 367 |
| 5 | 462.4 | 1108.6 | 10.74 | 105 | 58 | 352 |
| 6 | 666.4 | 1276.4 | 8.65 | 111 | 65 | 518 |
| 7 | 788.8 | 1717.6 | 5.72 | 120 | 82 | Outlier |
| 8 | 544 | 1126.5 | 9.54 | 109 | 59 | 367 |
| 9 | 652.8 | 1276.4 | 7.70 | 114 | 65 | 518 |
| 10 | 680 | 1364.0 | 8.10 | 113 | 68 | 634 |
| 11 | 571.2 | 1164.3 | 9.23 | 110 | 60 | 400 |
| 12 | 571.2 | 1164.3 | 9.23 | 110 | 60 | 400 |
| 13 | 707.2 | 1364.0 | 7.21 | 116 | 68 | 634 |
| 14 | 775.2 | 1717.6 | 6.43 | 118 | 82 | Outlier |
| 15 | 666.4 | 1364.0 | 8.10 | 113 | 68 | 634 |
| 16 | 666.4 | 1364.0 | 8.73 | 111 | 68 | 634 |
| 17 | 680 | 1364.0 | 7.21 | 116 | 68 | 634 |
| 18 | 802.4 | 1772.3 | 6.06 | 119 | 84 | Outlier |
| 19 | 666.4 | 1364.0 | 8.10 | 113 | 68 | 634 |

The instantaneous cutting rates of CAT-CM345 calculated using the prediction equations are now correlated with the measured instantaneous cutting rates to predict the Machine performance. All the predicted instantaneous cutting rates are found in closely correlated with the measured instantaneous cutting rates (MICR) (Fig. 2). A summary of the influential parameters used in these indices are enumerated in Table 6.

Table 6 - Performance predictions and their respective properties considerations

| Prediction model | Rock properties | Geological condition | Machine parameter | Co-efficient of determination ($R^2$) |
|---|---|---|---|---|
| Gehring (1989) | UCS | Not considered | Not considered | 0.865 |
| Copur et, al (1997) | UCS | Not considered | Power, Weight | 0.742 |
| Bilgin et al (1996) | UCS | RQD | Power | 0.871 |

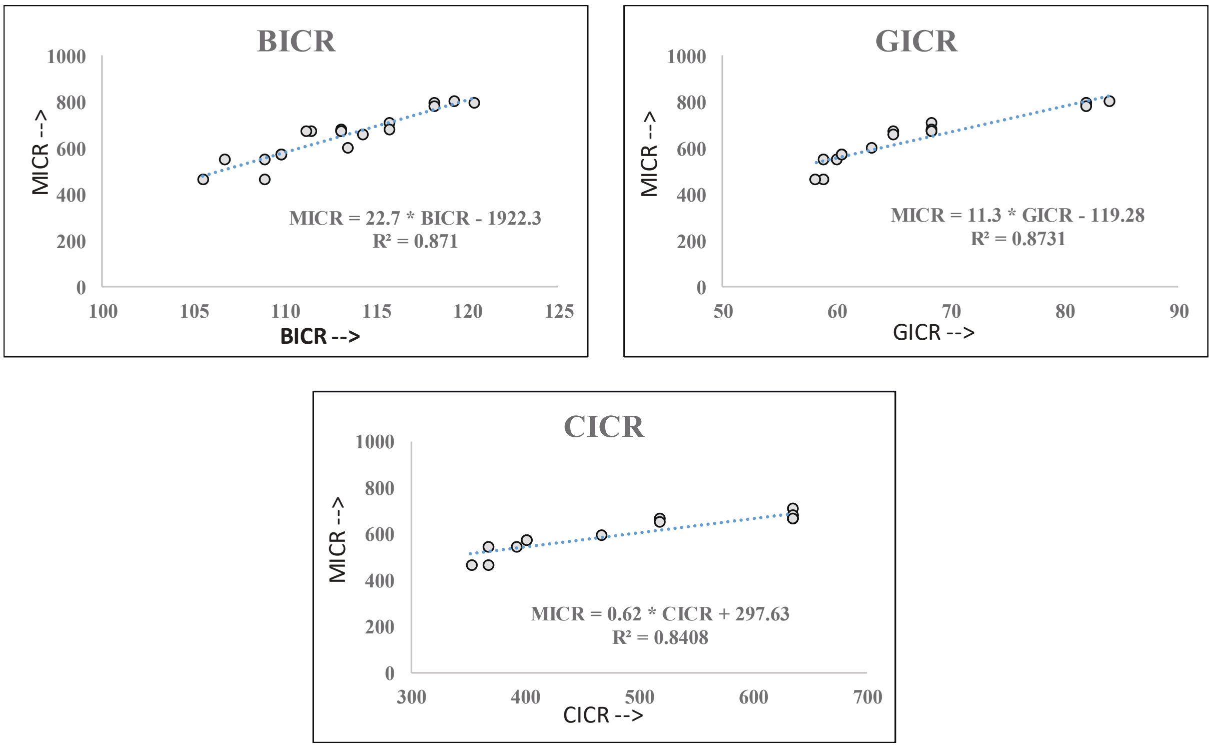


Figure 2 - Relationship between predictive indices BICR, GICR, CICR with cutting rate

## 4. DEVELOPMENT OF NEW CUTTABILITY INDEX

Based on the literature review the instantaneous cutting rate is found depended on many influencing parameters. Some of these parameters are also measured for each monitoring cases and bivariate analysis is carried out to check their influence.

It is found that MICR is inversely varying with the UCS (Uniaxial Compressive Strength) (Figure 3). The correlation between UCS with MICR is good ($R^2$ = 0.844). Similarly, MICR is also inversely varying with the BTS (Brazilian Tensile Strength) (Figure 4). The correlation between BTS with MICR holds good ($R^2$ = 0.65).

Considering this,a composite Continuous Miner Cuttability Index (CMCI) is proposed, in which the influence of UCS, BTS, RQD, Machine power and Machine weight are considered. The proposed CMCI model is -

$$CMCI = (P \times W)/((0.5 \times UCS \times BTS) \times (RQD/100)^{(1/3)}) \quad (13)$$

where

CMCI = continuous miner cuttability index,
P = power of machine (kW),
W = weight of the machine ( tonne )
UCS = uniaxial compressive strength (MPa),
BTS = Brazilian tensile strength (MPa), and
RQD = rock quality designation.

The cuttability index is calculated and correlated with the measured instantaneous cutting rates (MICR).

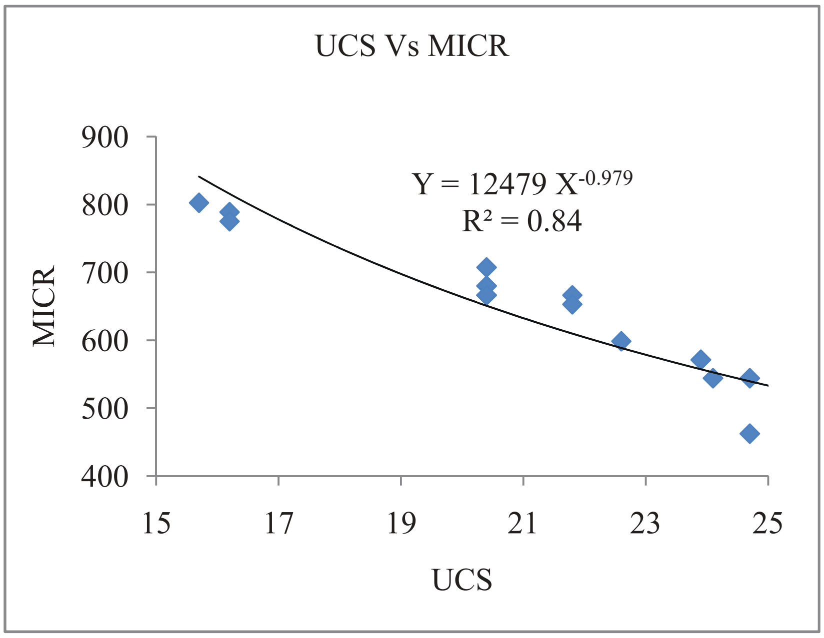


Figure 3 - Influence of compressive strength of rock on MICR

The continuous miner cuttability index (CMCI) calculated based on Eqs. 13 for 19 observed cases are correlated with the measured instantaneous cutting rates (MICR). The bivariate regression analysis is established with an index of determination of 0.84. The established predictor equation is presented in Equation 14. Hence, the developed statistical model for proposed predicted instantaneous cutting rate (PICR) based on the CMCI is:

$$PICR = 18.74 \times CMCI^{0.47} \quad (14)$$

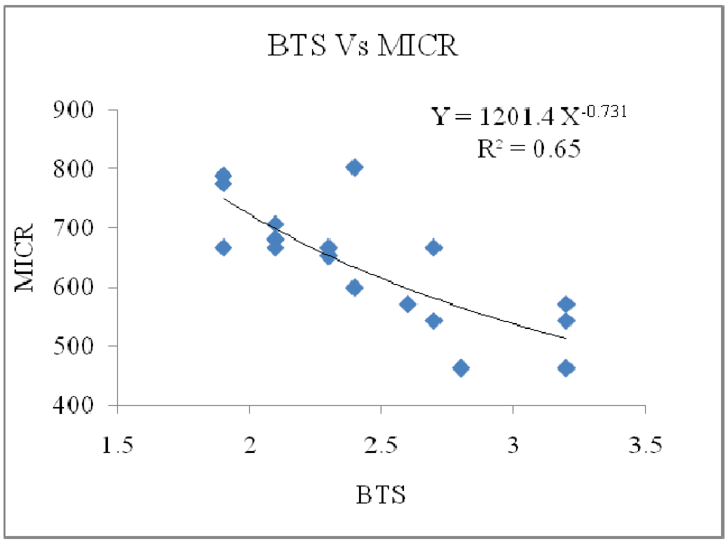


Figure 4 - Influence of tensile strength of rock on MICR

The above mentioned PICR is developed based on 19 different cutting cases. The PICR is predicting instantaneous cutting rate within a range of 0.2% to 17.6 % accuracy within its developed data set. Thus, to check the applicability of the developed model, it is tested with additional two different cutting cases which are not included in the development of the prediction equation. The geo-technical and machine operation and MICR data pertaining to these cutting cases as well as the calculated CMCI and PICR are given in Table 8.

Table 7 - Calculated continuous miner cuttability index (CMCI)

| S.No. | CMCI | MICR(tonne/h) |
|---|---|---|
| 1 | 2870.071 | 788.8 |
| 2 | 1726.163 | 598.4 |
| 3 | 1307.297 | 544 |
| 4 | 1294.839 | 462.4 |
| 5 | 1059.087 | 462.4 |
| 6 | 1761.882 | 666.4 |
| 7 | 3041.815 | 788.8 |
| 8 | 1132.984 | 544 |
| 9 | 1867.313 | 652.8 |
| 10 | 2062.11 | 680 |
| 11 | 1441.118 | 571.2 |
| 12 | 1170.908 | 571.2 |
| 13 | 2185.506 | 707.2 |
| 14 | 2870.071 | 775.2 |
| 15 | 1603.863 | 666.4 |
| 16 | 2194.681 | 666.4 |
| 17 | 2185.506 | 680 |
| 18 | 2376.621 | 802.4 |
| 19 | 2062.11 | 666.4 |

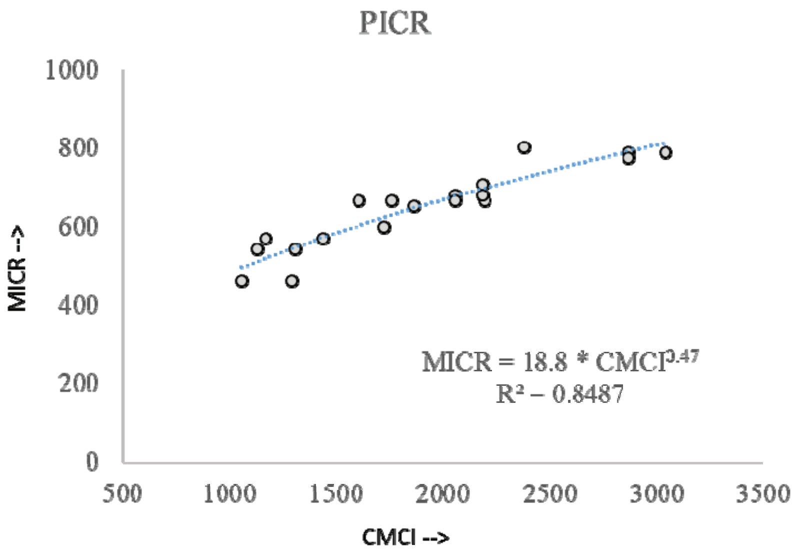


Figure 5 - Relation between CMCI and MICR

Table 8 - Calculated CMCI with additional two cutting cases

| S.No. | UCS (MPa) | BTS (MPa) | RQD (%) | MICR (tonne/h) | Power (kW) | W (tonne) | CMCI | PICR (tonne/h) | % error |
|---|---|---|---|---|---|---|---|---|---|
| 20 | 20.4 | 2.2 | 25 | 680 | 372 | 74.8 | 1968 | 664 | 2.30 |
| 21 | 23.9 | 2.5 | 24 | 570 | 372 | 74.8 | 1499 | 584 | -2.54 |
| 22 | 22.6 | 2.5 | 21 | 590 | 372 | 74.8 | 1657 | 613 | -3.85 |
| 23 | 21.8 | 2.1 | 21 | 670 | 372 | 74.8 | 2045 | 676 | -0.95 |
| 24 | 24.7 | 2.8 | 24 | 515 | 372 | 74.8 | 1295 | 546 | -5.95 |

The percentage variation of the MICR and the PICR of these five cutting cases are found to below 7%. These accuracies are found within the range of accuracy observed during the model development.

The proposed continuous miner cuttability index model (CMCI) is a useful tool to predict the instantaneous cutting rates (PICR). This small exercise will allow the production planner to schedule its transportation system, rock bolting system, machine allocation and material winding system. This tool will also help the mines to choose the suitable continuous miner models for deploying at the mines.

However, this present model is developed from a limited case studies. Especially, the variations in the machine parameters are not tested due to lack of availability of the other types of continuous miners. The similar studies on the other models of continuous miner may be carried out in future for modifying the statistical constants.

## 5. CONCLUSIONS

Continuous miner is becoming popular as underground coal cutting machine. The performance of the continuous miner can be modelled through the cutability indices. Performance of a continuous miner is monitored at underground faces to observe the cutter head-rock interaction. As the continuous miner is resembled to road header, the cuttability indices available for the performance prediction of roadheader are tried.

The correlation between Measured Instantaneous Cutting Rates and the calculated Instantaneous cutting rates using Gehring, Bilgin and Copur predictions are showing acceptable relation. However, their proposed prediction models for instantaneous cutting rate for road headers are not matching with the performance of continuous miner. This may be attribute by the weak strength properties of the coal, which is different from the hard rock excavation system.

Dependency of individual influencing parameters are tested with the instantaneous cutting rates for the measured cases and it has been found that instantaneous cutting rate is inversely proportional to UCS, BTS with acceptable correlation, however it shows poor correlation for RQD.

A new continuous miner cuttability index is developed using rock property (UCS and BTS) and rock-mass property (RQD) and machine properties (power and weight). The CMCI is developed using a set of 19 dataset to generate a predictive model for performance prediction of continuous miner in case of coal mining application. The developed CMCI model is correlated with the measured continuous miner performance and a statistical model is proposed for predictive instantaneous cutting rate (PICR). The developed PICR is tested for its applicability in case of five new dataset and the results are found to be within an acceptable accuracy.

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