

# Exploitation of developed coal mine pillars by shortwall mining—a case example

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## Abstract

The shortwall mining technique is similar to longwall mining but with shorter face lengths, ranging between 40 and 90 m, with the aim of controlling the caving nature of the overlying upper strata, the load on support and the overall operation of the supports applied at the face. Field observations and three-dimensional numerical modelling studies have been conducted for the longwall panel extraction of the Passang seam at Balrampur Mine of SECL to understand the caving behavior of the overlying upper strata. A large area of the Passang seam adjacent to the longwall panels has already been developed via bord and pillar workings. In this paper, numerical modelling studies have been conducted to assess the cavability of the overlying strata of the Passang seam in the mine over developed bord and pillar workings along with the support requirement at the face and in the advance gallery. The caving nature of the overlying rocks characterized by the main fall is predicted for varying face lengths, strata condition and depths of cover. The support resistance required at the face, the load in the advance gallery and its optimal obliquity were estimated for faster exploitation of the developed pillars in the Balrampur mine by shortwall mining.

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## 1. Introduction

In India, underground coal production is mostly dependent upon the conventional bord and pillar (room and pillar) method of mining, although the overall output per man shift (OMS) through this method is generally not more than 1 ton in any of the mines [1]. Large areas in all the subsidiaries of Coal India Limited and even in Singarani Coal Companies Limited (India) have been developed via bord and pillar workings. There is a need to search for a new method of mining for the faster exploitation of these developed pillars to improve productivity.

In this paper, the authors have conducted different numerical modelling studies using Fast Lagrangian Analysis of Continua (FLAC) software, to assess the

cavability of the overlying strata of the Passang seam in Balrampur Mine of SECL (India) over developed bord and pillar workings along with support requirements at the face and in the advance gallery. This study is based on field observations of a longwall panel and laboratory tested data of the overlying roof rocks as the input parameter for the modelling. The caving nature of the overlying rocks characterized by the main fall span is predicted for varying face length, strata condition and depth of cover. Further, optimal obliquity of the face was also estimated for faster and safe exploitation of the developed pillars by shortwall mining to improve the productivity.

## 2. Shortwall mining

Bord and pillar mining will not be a suitable option for developed pillars at higher depth cover in terms of

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Nomenclature		
$\sigma_h$	mean horizontal in situ stress	$\sigma_{cm}, \sigma_{tm}, b_m$ rock mass strength constants corresponding to the intact rock
$E$	elastic modulus	<i>RMR</i> Bieniawski's Rock Mass Rating (1976)
$\nu$	Poisson's ratio	$\tau_{sm}$ rock mass shear strength
$\sigma_v$	vertical in situ stress	$\mu_{0m}$ rock mass coefficient of internal friction
$\beta$	coefficient of linear thermal expansion	$\phi_{0m}$ rock mass angle of internal friction
$G$	geothermal gradient	$S$ pillar strength
$H$	depth of cover	$P$ pillar load
$\sigma_1, \sigma_3$	major and minor principal stresses	$W$ pillar width
$\sigma_c$	intact rock compressive strength	$h$ pillar height
$\sigma_t$	intact rock tensile strength	$B$ roadway width
$b$	exponent in the failure criterion	OMS output per man shift
		EMS earning per man shift

productivity, safety and percentage of recovery. The technology of shortwall mining overcomes most of the limitations experienced in operating longwall mining. In the Indian context, a face length of about 90 m is economically optimum with a moderately priced shearer and earning per man shift (EMS) as observed in the Indian longwall mining faces [2]. Shortwall mining of the developed bord and pillar workings would be a good option to overcome the limitations of the conventional bord and pillar method of mining.

### 3. Status of the Passang seam of Balrampur mine

The geo-mining parameters of the proposed area of the Balrampur mine for shortwall mining panel are given below.

Thickness of the seam	2.4 m
Proposed height of extraction	2.4 m
Depth of proposed panel	37–50 m
Existing overlying/underlying workout areas	Nil
Existing mining pattern	Developed on bord and pillar workings
Pillar size	20 m × 20 m (center to center)
Gallery width	4 m

Various boreholes have been drilled over the longwall panels P-1 and P-2 of Passang seam of Balrampur mine of the same area with results as given in Table 1. The average hard cover in panels P-1 and P-2 were 29 and 39 m, respectively, and the depths of the seam were 50 and 53.1 m, respectively. Based on the field observations of the caving nature of the overlying strata of the longwall panel P-1, the overlying strata have been

Table 1  
The borehole details over longwall panels P-1 and P-2 at the Balrampur mine

Borehole no.	Depth of seam (m)	Seam thickness (m)	Hard cover (m)
BIX-145 (behind panel P-1)	47.50	2.32	26.30
BIX-146 (middle of panel P-1)	49.30	2.28	24.30
BIX-144 (at the end of panel P-1)	48.90	2.50	38.55
BHP-2.1 (over panel P-2)	51.25	2.90	33.00
BHP-2.3 (behind panel P-2)	52.49	—	39.39
BHP-2.3 (over panel P-2)	53.6	2.60	41.00
BHP-2.4 (over panel P-2)	54.70	1.50	42.00

divided into six major beds overlying the coal seam. Based on engineering judgement and giving a higher weight to the borehole lithology in panel P-1, estimated RQD and the intact average compressive and tensile strengths of different bed rocks tested in the laboratory [3] are given in Table 2.

From the borehole details, it is evident that Bed-I and Bed-III are weak beds, with RQD of 40% and 43%, respectively. Bed-II and Bed-IV are relatively strong with RQD of 78% and 75%, respectively. It is expected that these two strong beds will pose difficulty for caving. Bed-V and Bed-VI consist of fractured/weathered rock and alluvial soil.

### 4. Field experiences of already extracted longwall panel

Longwall panel P-1 with a face length of 156 m, situated at an average depth cover of 50 m at the Balrampur mine was extracted with the help of the first Chinese powered support in 1998. In this panel, local falls had started taking place at regular intervals after a face advance of 25 m, involving the immediate roof fall

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