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An Assessment of Subsidence due to the Extraction of 1203 Slice with its Associated Factors in the Barapukuria Coal Mine, Bangladesh

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Abstract

This research, primarily the development of subsidence caused by the extraction of 1203 slice has been evaluated under the profile functions and influence functions methods and the results show that the calculated subsidence profile is almost trough like subsidence where the maximum amount of subsidence is about 0.89 m. In the latter cases, the different preceding research, scientific papers have been consulted and analyzed for recognizing the various influencing factors of subsidence which replicate that the geology and stratigraphic configuration, structural setting of the coal basin, hydrogeological characteristics, less competent nature of overlying rock body, dip and depth of coal bed, applied mining method with angle of draw (γ) and so on are the major factors in propagating the subsidence incident in the area. Moreover, the intensive field investigation recognized almost similar pattern of subsidence and its associated conscientious factors in the mine.

Keywords: *Barapukuria Coal Mine, Slice 1203, Profile Function Method, Influence Function Method, Subsidence.*

1. Introduction

The Barapukuria coal mine is located at 50km east of the district capital Dinajpur, the northwest part of Bangladesh (Fig. 1). Geological Survey of Bangladesh (GSB) discovered presence of extensive coal reserve at relatively shallow depth in April 1985 in Barapukuria [1]. With six layers the total reserve of coal is identified at average depth of 118-509m, among of them 6^{th} seam is most significant as it contain about 90% of the total reserve [2]. For coal extraction multi-slice Longwall mining method has been implemented for 34 years mine lifetime, with 1 million tons per annum production target when the mine has been extracting this bituminous coal since 2005. Recovery percentage of this mine is very low, about 10% of total reserve will be extracted. The principal reason for this low recovery ratio are the difficult underground geological structures and conditions for mining [3]. The 2,500 acres underground mine includes 650 acres of agricultural land on the surface. The International Accountability Project reports that mining operations at Barapukuria have destroyed roughly 300 acres of land, impacting about 2,500 people in seven villages, as land subsidence of over one meter in depth has destroyed crops and lands and damaged homes [4]. For instance large-scale land subsidence has occurred at Kalupara village, south-southeast of the Barapukuria mine, due to extraction of a 3m high section of mining panel 1101[5].

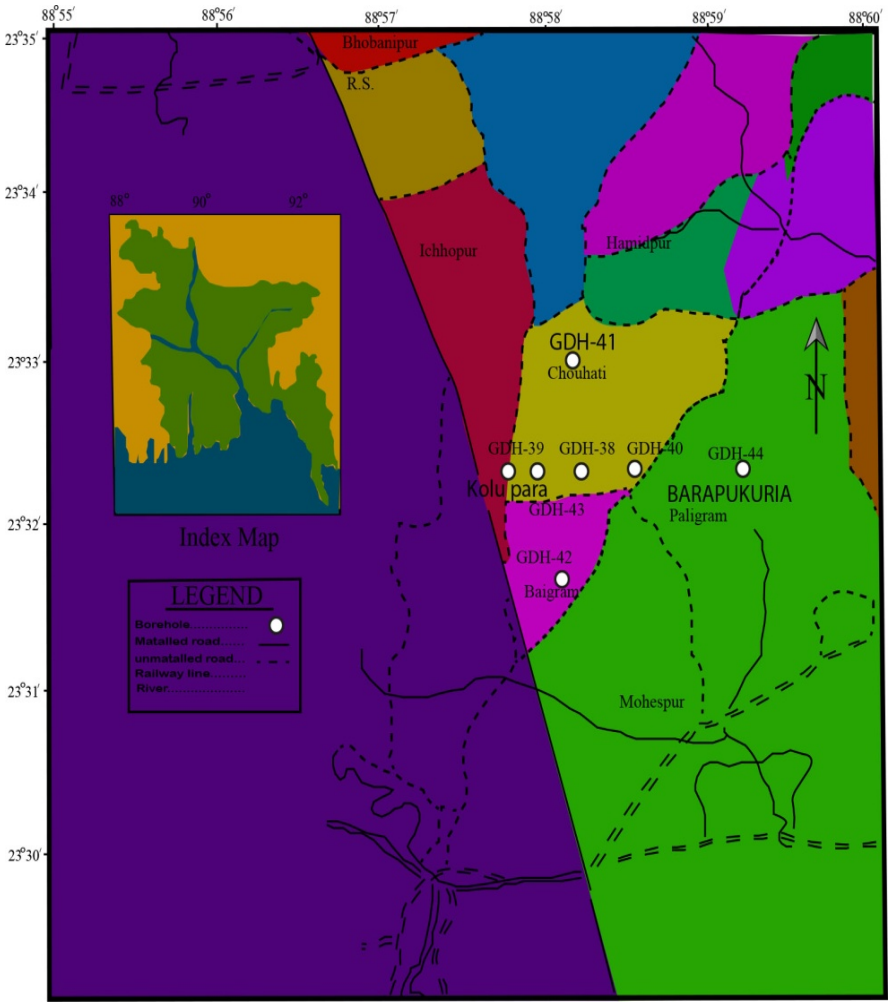

Fig. 1. Location map, total mining area and present working area

Coal mining industry itself is a very complicated technology, of which frequently faces problem in the mine. One of such problem in the mine is subsidence around the mining area and which is the common incident of such mine all over the world. Currently, the industry producing the coal from the mine by underground long wall pillar less mining method and some coal faces have already been finished as a result the mine out area is subsiding and will be subsided with time being. From my direct field observation, some of the area has been subsided about 2-3 feet or more and some of the house, plain land as well as cultivated land have fractured. From the common sense, these scenarios will be continued for long time and which would not good for local inhabitant as well as the mining industry. Therefore we have to take some preventive measures to reduce such incident around the area for sound and healthy production. In this case, to ensure the safe and healthy production, it is very much indispensable to figure out the pattern of subsidence over there. Therefore, the objectives of the research are to clarify the possible patterns of subsidence and its possible factors by direct field and laboratory analysis and, finally propose the necessary recommendations for preventing the subsidence for safely production of coal from the mine.

2. Methods of Study

In predicting the development of subsidence, two major assumptions are commonly made such as firstly the subsidence is proportional to the mined seam thickness; and secondly implies that subsidence at a point on the surface is a function of its coordinates with respect to the mined area, and that the maximum value of subsidence is observed above the geometrical center of the excavation. Whittaker and Reddish [6] consider five main groups of subsidence prediction methods, namely empirically derived relationships, profile functions, influence functions, analytical models, and physical models. Karmis et al. [7] consider three main groups of subsidence prediction methods such as theoretical models, numerical methods and empirical or semi empirical methods.

However the present research considered the profile functions and influence functions method for assessing the development of subsidence in the area. In the case of profile functions method, please see the Howladar [8] research paper where the detail processes of calculation of maximum subsidence, horizontal displacement and strain has been shown. On the other hand, the Influence Functions Method also applied for assessing and comparing its results with the profile function method. In this method, the subsidence at any point on the surface is obtained from the sum of the influence of each extracted element using the principle of superposition.

The direct field investigation has also been performed to clear the factors of mine subsidence around the mining area. During the field investigation the Geo-structural, Geo-hydrogeological**,** applied coal mining method, mine design and present situation has been investigated. The different research work, technical papers and analyses records were also consulted for the present this research.

3. Result and Discussions

The magnitude of the maximum subsidence is found to be increasing with the depth of the working and decreases gradually with larger depths [9]. However the development of subsidence has been predicted by many researchers such as Kratzsch [10]; Whittaker and Reddish [6]; Bahuguna et al. [9]; Chang et al. [11]; Quamruzzaman et al. [12]; Howladar [8] and others with different methods. In the present research, the Profile Functions Method and Influence Function Method have been appealed to envisage the development of subsidence incidences in the area. In order to perform these methods, the overall geometric parameters of 1203 long wall face have been considered. The parameters such as the thickness of coal seam is 3 meters, the mining depth or depth of overburden is 320 meters, the length of the long wall panel is 950 meters and the width of the long wall panel is 114 meters which are the common parameters for both of these methods. The computed horizontal stress, horizontal strain, distance from the center of the panel, inflection points are also the regular parameters and they are varied in a small amount. The predicted maximum subsidence with these methods is 0.89 meters shown in Fig. 2 and Table 2. Tthe type of subsidence is almost trough subsidence. From the field, it has been observed that more than one square kilometer have been subsided with a depth at the midpoint of the subsidence is about 1 meter which looks like a trough shape structure in the area. According to the principal of subsidence, the present research anticipated that this developed structure must be the trough subsidence which is also matched with pattern of subsidence predicted by Quamruzzaman et al. [12] and Howladar [8] in the case of 1101 slice with NCB and profile function method.

From the direct field investigation and laboratory analysis, it should be noted here that a number of geologic and mining parameters could affect the magnitude and extent of subsidence in and around the Baropukuria coal mine Dinajpur. These include the thickness of extracted materials; overlying mining areas; depth of mining; dip of mining zone; competence and nature of mined and surrounding strata; near surface geology; geologic discontinuities; fractures and lineaments; in-situ stresses; degree of extraction; surface topography; ground water (Including water elevation and fluctuation); mine area; method of mining; rate of advance; backfilling; time and structural characteristics.

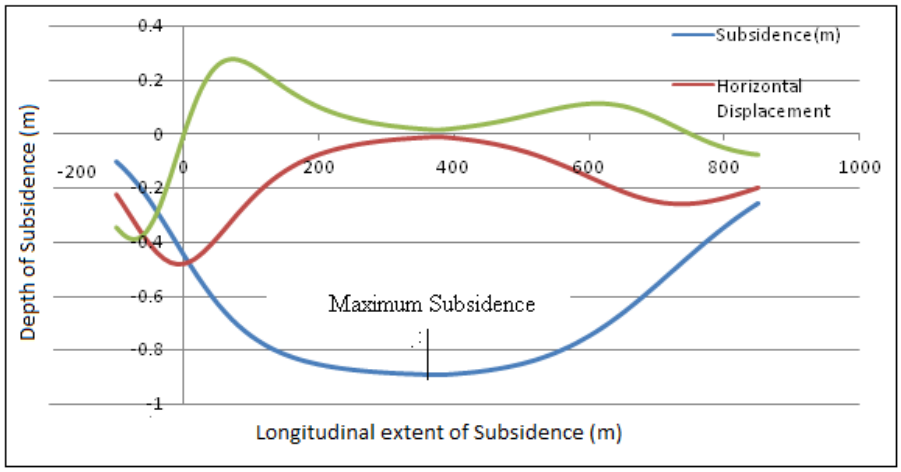

Fig. 2. Calculated maximum subsidence, horizontal displacement and horizontal strain profile from Profile Functions Method of 1203 Coal Seam, Barapukuria Coal Mine, Dinajpur.

Tables 2: Calculated Subsidence, Horizontal Displacement and Horizontal Strain values from Profile Functions Method (a) and Influence function method (b) of 1203 Coal Seam, respectively.

(a)

Distance(m)	Subsidence(m)	Horizontal Displacement	Horizontal Strain
-100	-0.10578	-0.22583	-0.34825
-70	-0.1841	-0.34093	-0.39082
-40	-0.28916	-0.44031	-0.29423
-10	-0.40952	-0.48317	-0.07842
20	-0.52765	-0.45661	0.137343
50	-0.62919	-0.38304	0.257155
80	-0.70817	-0.29571	0.276962
110	-0.76569	-0.21698	0.240866
140	-0.80604	-0.15502	0.188302
170	-0.83386	-0.10962	0.139403
200	-0.85296	-0.07751	0.100563
230	-0.86612	-0.05514	0.07185
260	-0.87527	-0.03959	0.051325
290	-0.88169	-0.02875	0.036853
320	-0.88627	-0.02113	0.026679
350	-0.88957	-0.01572	0.019504
380	-0.89125	-0.01299	0.015921
410	-0.88601	-0.02017	0.023842
440	-0.87817	-0.03046	0.034544
470	-0.86678	-0.04472	0.048251
500	-0.85068	-0.06372	0.064629
530	-0.82862	-0.08789	0.082407
560	-0.79939	-0.11698	0.099072
590	-0.76205	-0.14973	0.110907
640	-0.68121	-0.20518	0.108849
670	-0.62285	-0.23297	0.090582
700	-0.55944	-0.25218	0.060882
730	-0.49369	-0.26048	0.02463
760	-0.42851	-0.25749	-0.01175
790	-0.36652	-0.24466	-0.04259
820	-0.30968	-0.22465	-0.06456
830	-0.29209	-0.21691	-0.06973
840	-0.27525	-0.20882	-0.07386
850	-0.25914	-0.20049	-0.07699

b.

Distance(m)	Subsidence(m)	Horizontal Displacement	Horizontal Strain
-100	-0.10578	0.152569	0.552161
-70	-0.1841	0.357377	0.838437
-40	-0.28916	0.576353	0.71759
-10	-0.40952	0.686859	0.199077
20	-0.52765	0.640367	-0.3465
50	-0.62919	0.489159	-0.61909
80	-0.70817	0.317896	-0.60358
110	-0.76569	0.181264	-0.44458
140	-0.80604	0.093006	-0.27328
170	-0.83386	0.043846	-0.14751
200	-0.85296	0.019322	-0.07223
230	-0.86612	0.008073	-0.03284
260	-0.87527	0.003237	-0.0141
290	-0.88169	0.001257	-0.0058
320	-0.88627	0.000477	-0.00231
350	-0.88957	0.000178	-0.0009
380	-0.89125	9.18E-05	-0.00047
410	-0.88601	0.000477	-0.00215
440	-0.87817	0.001937	-0.00759
470	-0.86678	0.006328	-0.02141
500	-0.85068	0.017044	-0.04923
530	-0.82862	0.038657	-0.09405
560	-0.79939	0.075246	-0.15148
590	-0.76205	0.127811	-0.20778
620	-0.71625	0.19227	-0.24375
650	-0.66246	0.259534	-0.24312
680	-0.60215	0.318028	-0.20047
710	-0.53764	0.357447	-0.12387
740	-0.47176	0.371906	-0.03102
770	-0.40738	0.361156	0.058046
800	-0.34693	0.329751	0.12774
830	-0.29209	0.284942	0.170382
840	-0.27525	0.268378	0.178415
850	-0.25914	0.251451	0.183566

4. Concluding Remarks

Barapukuria Coal basin in Dinajpur district, Bangladesh enters into the coal mining era for the first time. As the country having no coal mining experience in the past, Barapukuria Coal Mining Company is expected to bring about a number of others mining related activities in the country. Barapukuria coalmine is now currently under production mode and facing the very great problem on subsidence around the mining industry. Considering this point of view, the present research deals with understanding the subsidence, and its possible factors by direct field investigations and laboratory analysis. The investigation shows that the trough subsidence developed around this mining field which is caused by many factors such as applied mining method, multi-sliced ultra thick coal seams, less competency of overburden strata, depth & dip of the coal seam, existed geologic discontinuities such as faults, Joints, fissures and other inconsistencies in the overlying and surrounding strata.

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