

SUBSIDENCE – A MAJOR EFFECT OF COAL MINING IN RANIGANJ COALFIELD

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ABSTRACT

Coal, the most important fossil fuel in India is vital for industrial growth. It is India's least cost source of primary energy and currently meets two-thirds of the country's energy needs. The state of West Bengal has rich deposits of coal and, accounting for about half of India's total. Over 240 years coal is being produced from Bengal which has major consequences on the environment.

Un-scientific, unsystematic and illegal mining are the primary causes of fires resulting into subsidence in large part of Raniganj coalfield area. Intensive mining activities during the past by over thousand small fragmented mines have created many complexity for future development. Coal, which are left as safety pillars and ribs during the course of extraction (mining) in old workings and abandoned mines, catches fires due to spontaneous combustion and gets further aggravated due to illegal mining, resulting into subsidence. Mining-induced subsidence, cause horizontal and vertical movements in the land surface, and open cracks and fissures that serve as inlets for oxygen, which in turn aggravate the problem of coal fires. These inter-related phenomena often render the mining areas unfit for human habitation. The population living in the old mining areas has increased many times over the years, though these areas became unsafe for habitation. With gradual industrialisation in this area, haphazard and unplanned growth of surface construction have emerged. Over 4400 million tones of valuable coal reserve lie below such townships which will affect future mining operation. The study is related to Subsidence and its effect occurred due to coal mining operations in Ranganj Coalfield area for centuries.

Key Word Subsidence, Fire, Rehabilitation Technologies

Introduction

Raniganj Coalfield covers an area of 443.50 km² (171.24 sq mi) and has total coal reserves of 49.17 billion tonnes, spread across Indian states of West Bengal and Jharkhand.. That makes it the second largest coalfield in the country (in terms of reserves). Coal was needed initially by the British Rulers to forge guns in order to rule India and indiscriminate coal extraction continued in Bengal starting as back as 1774. About 200 years prior to

nationalization of coalmines, barring a few reputed companies, unscientific mining was carried out under shallow cover, which has resulted in some areas of Raniganj Coalfield being threatened with subsidence besides serious environmental hazards such as the occurrence of coal fires. Such fires burn away the natural non-renewable coal resources, locally raise the temperature of the area, and emit polluting gases like oxides of carbon, sulphur and nitrogen.

Raniganj Coalfield, which falls under Eastern Coalfields, is the birth place of coal mining in the Country. Here coal is produced from two distinct types of mines; Underground and surface (opencast) Mining Overall ecological imbalance is high in this area..

Though the primary concerns at the regional levels is with the environmental impacts on air, water, forest, biodiversity, climate and the costs of mitigating these but above all land damage and subsidence become the major concern for life and property of the habitants.

History

Raniganj area has high quality of huge coal reserve. Though coal mining was first started in 1774 in Asansol area but coal industry in fact started taking shape during 1840 when coal was produced on commercial basis .

Notwithstanding above, the coal industry faced the most difficult economic problems in its history from 1927 due to continuous fall in coal price. Many collieries were closed down but others in an attempt to survive in the face of steadily falling prices resorted to expanding outputs through slaughter mining. Moreover, during World War-II in 1940's heavy demand of coal resulted in undue splitting of standing pillars without any consideration of strength of the remnant pillars/stocks (*p 143 of report in chapter 10 of INFLIBNET Centre Sodhganga (internet)(15)*).

In the old days when the surface was not densely populated the operators had extracted as much coal as possible without stowing or supporting. The surface rights were generally not acquired.

In course of time when these holdings were abandoned habitation started growing over the old workings, initially slowly but subsequently at a rapid pace. Growth of population took place for various reasons, such as general growth of population, migration of population from distant villages to areas adjoining coal mines in search of livelihood and growth of business and industry in Coal belt. This further accelerated after nationalization of coal mines in 1973. Large numbers of pot holes had occurred indicating ground movement. Aging of pillars and subsequent weathering effects are continuous. These old workings are now waterlogged. Equilibrium is being maintained in the old waterlogged workings due to hydrostatic pressure. Collapses may not be ruled out once water level is lowered down.

Subsidence

Coal production adversely affect local environment and some time cause recurring problems .On the topic of environment, subsidence, will be most relevant due to its magnitude which have of late captured the minds of general public,

Subsidence can be planned or unplanned. In case of planned subsidence prior permission from Director General of Mines Safety is obtained for extraction of coal by caving along with acquisitions of land at the surface likely to be affected. Planned subsidence is followed where there is no surface feature.

Unplanned subsidence occurs mainly due to very old abandoned underground workings. As already said, coal mining in this coalfield started more than 200 years ago. Upper coal horizons at shallow depths had been worked in the past, most of which are standing on pillars which are getting reduced due to ageing, endangering the stability. These old workings are now mostly waterlogged and inaccessible. In most cases, abandoned mine plans of these old workings are not available and when available, are not reliable. Dewatering of these old workings by itself may trigger subsidence and may also lead to fire. Population has grown in an unplanned manner over the coal bearing areas including over these abandoned shallow workings. Since the strength of coal pillars in these old workings are getting reduced due to ageing, there is apprehension about their stability and consequently of the habitation that has grown. (P,108 of the book 'Two Decades of Eastern Coalfields' published in 1995 by ECL).(14)

As mentioned earlier the extent of the old working and their exact present condition are not known. It is essential, at the first instance, to identify and delineate the voids in the water logged accessible workings before stabilization of these workings is undertaken. To protect even a small structure on the surface a very large amount of coal underground has to be left unworked. The highly adverse effect of uncontrolled building construction over mining areas would be obvious.

The problems of Subsidence and degradation of land

The problems of Subsidence and degradation are of many folds:

1) The presence of old and water logged working is the major problem in Raniganj coalfields. There are some localities, which are situated above the water logged (unsafe residential) areas. Natural hazards and coal mining subsidence can have a detrimental effect on land uses. Structures can be demolished, rendered unusable or made uninhabitable instantaneously or in a short space of time. This type of devastation has economic and social ramifications for the community. Overburden dumps and open pits also increase the problems of land degradation.

2) The philosophy of "More coal -More whole" adopted by some small coal operators in Raniganj Coal field, led to haphazard coal extraction. Unfortunately interest of getting more coal in a shorter period leads people to unscientific mining. As a result there are long list of unstable areas. Due to age-old problem of subsidence — the gradual movement or sometimes abrupt collapse of the rock and soil layers into an underground coal mine - which can disturb the surface above the mine This resulted in serious problems like incidence of fire and subsidence.

3) The population living in the old mining areas has increased many times over the years, though these areas became unsafe for habitation. In spite of the declaration of these areas unsafe by the local administration, the habitation increased unabated.

The problem of subsidence and fire are being addressed by the Government from time to time. Some types of hazards can be avoided or mitigated by undertaking a proper risk assessment of the situation and by designing subdivisions to minimize the risk, or in some situations, by not proceeding with development as the risk may be too great. However due to problems it was difficult to ascertain the extent and magnitude of subsidence. With the passage of time it has been ascertained that the total underground fire area in Raniganj Coalfield (within the basin) is 5.88sq. km. while the subsided area is 29.4sq. Km (as per ECL Data book, 2005). It has been increasing in last 5 years and in the near future also, as more and more coal is to come from underground method, more area is likely to be degraded due to subsidence.

Formation of Committee:

Prior to nationalization concern for environment and its protection was practically non-existent. After nationalization environment consciousness started taking concrete shape in the form of enactment of legislation by the Govt. However, meaningful studies for the identification of the problems and key areas for environmental protection in the coal belt vis-a-vis coal production was initiated.

The problems of danger of subsidence of surface land over old abandoned & unapproachable mine workings, standing on small stokes the size of which is unknown has attracted the attention of authorities concerned, technical organizations and institutes from time to time.

The study of surface subsidence fire and water logging in abandoned colliery workings was conducted in the past by several committees which made their recommendations from time to time.

The first subsidence committee was formed in 1922 by Mining Metallurgical and Geological Institute of India. The committee could achieve little success due to many constraints. Second committee constituted by Mining Metallurgical and Geological Institute of India in 1937. The committee report was however not available.

Later various committees like Bagchi Committee, Prasad Committee, had examined the issue of dangers arising out of presence of old workings in Raniganj coalfield. These committees had declared certain localities to be unsafe and unstable.

In 1978 a committee set up by the Government of India had examined all the subsidence prone areas due to presence of old/ abandoned workings underneath. Government of West Bengal had enacted a legislation called the West Bengal Restriction on Construction in Unsafe Areas Act, 1979 for prevention of construction over the areas declared unsafe despite of this enactment; construction had been going on over many unsafe areas

Apex Monitoring Committee (AMC) for Raniganj Coalfield constituted by West Bengal Govt. in consultation with Coal India (CIL) was entrusted to suggest measures to be adopted for ameliorating different environmental problems of Raniganj Coalfield including the apprehended subsidence problems.

The Committee comprises of H.B.Ghosh ,Ex-DGMS as Chairman and representatives of Central Mines Research Station, Director General of Mines Safety (DGMS), Indian School of Mines ,West Bengal Govt. ,Central Mine Planning & Design Institute, Eastern Coalfield Limited as well as people's representatives.

This committee examined the localities reported to be subsidence prone due to presence of old workings and had identified 49 localities as unstable in June'92 of which 11 were found to have no apparent danger. However 21 more localities were examined by AMC later in Sept'95 of which one was found having no apparent danger. In addition to the areas examined by the Apex Monitoring Committee (AMC) ECL and CMPDIL identified 2 more unstable areas. Thus a total of 72 unstable areas were identified in which seven locations comprise of part of rail, road etc.

Out of these 72 locations, the population of one site was rehabilitated. However, in these 71 areas,(12 have no apparent danger), inhabitants from 47 areas required to be rehabilitated and 24 locations being densely populated were considered for stabilization (*coal and its environment by S.N.Singh ECL p 78 ,79,80 81 of book coal Industry in the 20th century Published by BCCL Sept 1999*)(17)

An estimated population of 134785 were requiring resettlement/rehabilitation Resettlement/rehabilitation of this magnitude was an uphill task which might not be possible and feasible. So an attempt was made in the 2nd report based on the following criteria to reduce population to be rehabilitated.

- i. Underground plan not available.
- ii. Workings on fire.
- iii. Less populated.
- iv. Illegal mining.
- v. Recent history of subsidence.
- vi. Stowed workings.
- vii. Apparently no workings below.
- viii. Workings on normal size pillars.

A High Level Committee was constituted with Secretary Ministry of Coal as Chairman to go into the problem of subsidence & fire in Raniganj Coalfield to suggest mitigating measures. The Committee submitted its report in January'98. The recommendations of the Committee were accepted by the Govt, of India and the implementation statuses of the recommendations were(*p 146 of report in chapter 10 of INFLIBNET Centre Sodhganga*)(15):-

Recommendation I

Wherever possible, settlements of all unstable areas should be shifted to non-coal bearing zones.

For this purpose, satellite townships considered the best long term solution against subsidence hazards in the coalfields Drawing a comprehensive Master Plan to deal with the problems of fire, rehabilitation and subsidence control by . CMPDI RI-1, Asansol Environmental Measures and Subsidence Control (EMSC) schemes to generate base line data to prepare the Master Plan considering the following aspects:

- i. Generation of data and identification of subsidence prone areas and its segregation into controllable and uncontrollable areas in the leasehold of Eastern Coalfields.
- ii. Technological Measures for control of subsidence where feasible, assessment of evacuation and resettlement needs where subsidence control is not feasible and assessment of fund in the leasehold of Eastern Coalfield Limited.

The locations which do not fall under the above categories are considered for stabilization in spite of the fact that present technology of hydro pneumatic stowing is a slow process and reliability being doubtful.

Recommendation II

There should be total ban on any new construction over declared unsafe areas in the coalfields.

Recommendation III

For tackling the problems of fire and subsidence, the participation and assistance from State Government and local administration is essential.

Constitution of:

- i)A core committee consisting of CMD, ECL District Magistrate Burdwan and Director, Commerce Industries Department, Govt, of West Bengal.
- ii)A core group consisting of representatives of ECL, CMPDI, Regional Institute, Asansol& local administration..

Recommendation IV

The mitigation measures against subsidence and fire hazards are very costly options and fruitful implementation of these measures can only be possible through separate executing agency with separate funding. Formation and representatives of such agencies responsible for formulating schemes, their implementation and management of funds should be finalized at the earliest .

However ,the agency for implementation *of* these Projects was decided .to be Asansol Durgapur Development authority with fund provided by Govt. of India.

On the basis of Apex Monitoring Committee recommendations Central Mine Planning & Design

Institute formulated project reports and a Master Plan

As per the Master Plan prepared for Raniganj Coalfields, 13 future townships are identified and it may be pertinent to mention that all these 13 areas are non coal bearing zones. That for the purpose of rehabilitation, core group consisting of state authorities, ECL and CMPDIL were constituted to give a final shape to the scheme of re-settlement. For the purpose of rehabilitation of the people living in the unstable areas, the following 4 villages were identified namely Samdi, Kenda Village, Harishpur and Bengal Para, where village committees was constituted and the identification of alternate location has been done.

Though a number of meetings with the local committee members and inhabitants were held yet no concrete decision could be arrived at with regard to resettlement (P.144 of report in chapter 10 of INFLIBNET Centre Sodhganga) (15)

On the basis of Apex Monitoring Committee, B Bagchi committee ,Prasad committee .area wise estimation of population likely to be affected of Eastern Coalfields In 2010 was 134775 Area wise position(the ten administrative areas of ECL) of unstable locations given below will indicate the extent of problem of subsidence ,in Raniganj coalfields.

Table I Subsidence in Raniganj coalfields (*Source CMPDIL Report*)

Sl no	Area	No. of unstable locations	No. apparent danger	Rehabilitation location	Estimated population likely to be affected	No. of houses	No. of houses
						Apparently stable	unstable
1.	Salanpur	1	1		1000	53	150
2.	Sripur	22	1		71023	195	10597
3.	Kajora	3	1	1	3300	140	545
4.	Kunustoria	8	1		15755	120	2434
5.	Kenda	3	1		7400	192	1194
6.	Satgram	8	1		12600	20	1791
7.	Sitarampur	5	3		9810	384	1508
8.	Sodepur	3	2		11700	1000	1053
9.	Pandaveswar	1			275		60
10.	Bankola		1		50	11	
	TOTAL	54	12	1	159013	2115	24264

Subsidence in different collieries of Eastern Coalfields up to 2008

Source: Feedback Report. CMPDIL (8)

ECL Area wise position of unstable location (2010)

Sodepur Area

Sodepur is the area, where frequent accidents due to coal mining occurred. In past. Area was wounded by more than ten fires and more than five subsidence's. The area is completely devoid of vegetation so soil erosion is also high and the small *nala's are* silted. As a result overall ecological imbalance is high in this area.

Sanctoria village lying over abandoned workings of Sanctoria colliery .where on 27th November 2004 one primary school building and a ECL Bungalow collapsed and several residential houses were severely affected. The ground movement led to the development of the surface cracks up to 30cm wide. Earlier ground movement occurred in 1997 and 2000.moving from east to west following the fire movement in the coal seam.

Sanctoria village lying over abandoned workings of Sanctoria colliery .

The maximum effect can be seen in Sodepur with almost 5000 people inhabited.

Earlier the area was affected by gigantic digging for coal unscientifically.

Sitarampur Area

In this area only Pathmohona is the place where there is total instability

Salanpur area

In Salanpur area two collieries' area namely Bonbiddi village and Balsuk ceramics & colony have been taken to quantify the affected population. The unstable part in Bonbiddi is in north east and the western part of Balsuk ceramics & colony. We can see that Balsuk ceramics & colony is much more affected by the instability due to excessive extraction of underground coal. The area early were effected by illegal miners by indiscriminately withdrawal of coal, hence lack of sandstowing in the area it became unstable.

Sripur area

Due to major subsidence the newly constructed National high way from Kalipahari Rail gate towards Neamatpur got subsided to a depth of 2.6 -4 Meter with a length of about 1500 meter in 2006-7

Other unstable areas are Banksimulia, Bhanora, Rana, Adjoy II, Bhanora, Charanpur East, Bhanora & Apcar's Charanpur, D. Bright's Rana, Kalapahari, Sheebpur, Sripur, Grimint, Grimint, Dhadka, Sripur no.3 incline, Bhutdoba, Kalipahari, sheebpur, Jamuria 5, 6, 110 & 11 and Damodarapur, Jamuria 5, 6, & 11 and Akhalpur 1 & 2 pits, Central Jamuria, Poniaty, New Ghusick, kalipahari. In maximum case not partly but the whole area is unstable. In some case the total village is hanging on the hollow and void coal seam. Kuccha houses are mostly available, so with the arrival of minimum shake they are unable to resist. The situation of these areas is really alarming..

Satgram Area

The unstable locations are Mithapur village. Jaba village & IOC pipelines. Bogra village One DB road on south of Jaykaynagar One road to Jaykaynagar. Santhal bastes. Eastern railway main line. 11 KV HT line & DB Road. Basti on the East .Agent & Manager's bungalow & staff quarters. Kuardih village. No.4 pit quarters.

Kunustoria Area

Apparently stable and already the inhabitants were rehabilitated .

Identified unstable areas of - Kunustoria Area is In pottery area where the effect is maximum. South Parasea, Toposi ,JoteJanki Carr & Tagore Krishna coal co. Pottery, Porarbandh, Raniganj, Kumar bazar **Kenda Area**

Kenda area is generally disturbed and already announced as highly risk zone.

Some parts are rehabilitated and some parts are abundant. The area of New Kenda is under severe condition as the Coal seam underneath is partly water logged so the houses are very prone to subsidence. People of Kenda were proposed to resettle

At Mangalpur in Raniganj. But they had refused as stated.

Kaiora Area

Apparently stable and affected people were already rehabilitated.

The area is basically with low disturbance .So population in this area affected lower than the previous one. Here maximum people are engaged in mine office works. So *pucca* houses are very common.

Bankola Area

Unstable areas are Khandra habitats, a part of Co's Quarters, Electric Sub - station & A part of Ukhra village, another Bastees and Football ground., Part of Shankarpur village., Part of Bonbahal village. Co's quarters, building, road etc.

Moirra village, its extension. ECL's single & double storied ,pucca building, hospital and PWD and colliery roads.

Pandavaswer Area

Unstable areas as identified are Danya village & Rly line., few huts and football ground. Samla panchet office temple kutch Road. ECL quarters .11 KV H.T line (WBSEB) Public road Bengali bastes, ECL qrts, building Elec .sub-stn on the west side Raniganj] - Suri road. Raniganj - Suri road and petrol pump, health centre on the eastern side of the road. Andal - sainthia chord line and siding roads ECL bungalows, qrts. Bustees. Etc

.Govindapur village bustees tanks rly sliding etc.

The list of unstable location will speak about the magnitude of the problems

Indigenous Technology to deal with Subsidence

There is no proven technology either for delineation of in accessible underground voids or for stabilization of inaccessible waterlogged workings. An innovative technology of hydro pneumatic stowing of inaccessible waterlogged workings was conceived and designed by H.B.Ghosh in early Eighties. The technology was given laboratory trial by Sri N.Sar,the then General Manager of KunustoriaArea .A Pilot project for field trial under experimental conditions was undertaken by ECL at Ramjivanpur Colliery in 1985 which was successfully completed in 1988 (p,109of the book 'Two Decades of Eastern Coalfields' published in 1995 by ECL).(17)

On the basis of encouraging results obtained at Ramjivanpur, another field trial of hydro-pneumatic stowing under actual field conditions in an area covering part of Ranlganj township was undertaken by ECL .The stabilization in this place was in progress under close monitoring by a Core Group of Apex Monitoring Committee. The progress of the project was rather slow as it has been facing unforeseen problems..These unforeseen problems as and when came up .were investigated and solved by the Core Group, for which CMRS has been entrusted to conduct simulated model study.

In the absence of any proven technology for stabilization of old inaccessible waterlogged working, this indigenous technology of Hydro pneumatic technology was adopted for stabilization in 9 sites viz. Fatehpur, Barachak,Haripur, Arun Talkies, Kumarbazar, Gowalabasti, PorarBandh, Pottary&Sanctoria

Task and Action plan formulated as under:

A. Dealing with fire

- 1 Total no. of existing fires 7
2. Estimated Cost (Crore) 40.28

B Rehabilitation

- 1 No. of sites to be Rehabilitated- 139
- 2 Area affected in sq km 8.62
- 3 No. of houses to be Vacated/ Rehabilitated 33196
- Population covered 180263
- 4 Land required for rehabilitation (Ha) 896.29
- 5 Estimated Cost (Crore) 2610.10

C. Diversion of Railway line/ Road/OC pipeline 7 sites Planning and survey with an outlay of Rs.20 Crore

Estimated Cost (Crore) 11.35 20.00

D. Implementing Agency for fire projects &

rehabilitation of / ECL houses ECL

E. Implementing Agency for rehabilitation of Non-ECL houses-Private & Encroachers

Asansol Durgapur
Develop Authority
(ADDA), Govt. of
WB

F Implementation Schedule,) + 10 (in two Phases
each of 5 years)

G Estimated Capital Requirement for fire projects,
rehabilitation& diversion of rail/road/ pipeline
etc. (` Crore) 2661.73

Asansol Durgapur Development Authority (ADDA) have been identified as implementing agencies for rehabilitation purposes. on behalf of Government of West Bengal and Government of India .Coal companies and ECL will provide technical support and the outlay will be funded particularly through the internal resources of CIL and the cess collection under CCDA(*Safety in Coal Mines Chapter 9 Page 57 & 58 Report of Ministry of Coal 2010*)(6)

,According to the directives of the Hon'ble Supreme Court of India ADDA has completed the entire survey work including demographic and measurement & valuation of superstructures of respective declared unstable locations.

The Technologies:

Initiatives have been taken to develop device with appropriate audio-visual alarm to monitor the behavior of overlying roof strata.

Several roof-monitoring devices have been developed at Area/Mine level workshops.

Type of Strata Monitoring Devices used in some of the UG mines of CIL like 1. Auto Warning Tell-Tale 2. Multi Point Bore Hole Extensometer 3. Magna sonic Extensometer 4. Telescopic convergence recorder 5. Remote convergence recorder 6. Stress Meter

In a coalfields in north-west China for the study, to identify the areas affected by coal fires and land subsidence satellite data was acquired in three regions of the electromagnetic spectrum, namely optical, thermal and microwave, along with field data, for an integrated analysis of this complex problem.

However Rock mechanics theory needs to be applied to solve ground control problems.

Recommendation

To improve safety standard, CIL has vigorously pursued several measures in the year 2013 along with on-going safety related activities / initiatives apart from compliance of statutory requirements for safety, which are given below

Continuous review of safety status of mines is being done through the multi-disciplinary Internal Safety Organization (ISO)

CMPDI has been assigned with the task of regularly conducting satellite surveillance study of projects of ECL.

Technical recommendations to avert Subsidence With present status
(As per Cil Guideline in 2013) (7)

1. Stowing and depillaring shall be as per the recommendations of the DGMS. Status- There is no plan for stowing and depillaring as there is no UG mining operation at present. xxiii. The proponent must comply with the Raniganj Action Plan.

The unstable areas within the cluster will be brought under plantation after the population residing over these areas is rehabilitated under the Master plan for Raniganj Coalfield to be implemented by ADDA.

The recommendations with regard to control of Subsidence and present position/ status has been highlighted

O. Trees with deep rooted system should be planted so as to prevent soil erosion.

No soil erosion within the mine leasehold area is identified.

O. Proponent should plant additional 10 Ha/ year over the next 10 years at various locations in this Cluster. Depending upon the availability of land further plantation will be done.

O. River/nallahs shall be de-silted and restored back to functional state. There is no siltation from mines into river/nallahs. However cleaning of nallahs is an annual pre-monsoon activity in each mine of ECL.

O. Separate drainage pattern be provided. Drains are provided wherever necessary.

No depillaring activity (caving/stowing) is being done; there is no subsidence at present

Sand stowing must be used as recommended by CMPDI. Presently there is no depillaring activity is going on, hence, no sand stowing is required

O. Action plan for prevention and mitigation of subsidence be prepared and implemented.

O. No depillaring activity is presently under taken.

After completion of mining activities, the subsided areas shall be graded and planted upon.

Presently there is no subsided area. Subsided areas, if occurring during mine life will be graded and planted upon.

O. No depillaring activity is presently under taken.

Coal extraction shall also be optimized in areas where agricultural production is continuing. Some pillars shall be left below the agricultural land.

No depillaring & coal extraction should be carried out below habitation, H.T. Lines beneath road, water bodies. Coal pillars will be left intact to protect surface features like H.T. lines, roads and water bodies.

O. The land excavated after mining must be brought back to original condition for agricultural / plantation purpose. The land excavated after mining will be backfilled concurrently, which will be suitably reclaimed at later stage as per provisions of Mine Closure Plan(MCP)No major subsidence has taken place during last few years

O. Regular monitoring of subsidence movement on the surface over and around the working area and impact on natural drainage pattern, water bodies, vegetation, structure, roads, and surroundings shall be continued till movement ceases completely.

No depillaring activity (caving/stowing) is being done; there is no subsidence at present

O. In case of observation of any high rate of subsidence movement, appropriate effective corrective measures shall be taken to avoid loss of life and material. Cracks shall be effectively plugged with clayey soil/suitable material.. If subsidence is found exceeding the permitted limits, then the landowners shall be adequately compensated with mutual agreement of the land owners. No subsidence has been observed from older UG mine workings.

Conclusion

Not much study has been done towards the reclamation of subsided land in Indian coalfields. In a few areas of *Raniganj* coalfield including *Ninga* and *Sripur*, plantation on subsided land has been attempted.

The scientists are of the opinion that before starting reclamation of subsided land, the purpose of reclamation in terms of “land use” should be finalized in consultation with the local people. The most important thing is to plug the cracks and it may not be necessary to bring the subsided land to its original state even for use for agriculture, plantation and housing.

Some researchers claim that improvements in water retaining capacity of the subsoil in the subsided land are required.

There is no specific legislation in India concerning subsidence, but as per common law, the coal company is to acquire the surface right of the property in which subsidence may occur due to

underground mining. In some countries, there is specific legislation guiding the coal industry in matters of subsidence and perhaps such enactment may be necessary in our country also.

Even with its major hurdles, coal will continue to dominate the energy sector in the country for some years and will occupy in future a foundation and a fundamental source of Indian economy. Thus a holistic approach for taking up to present and future mining activities, keeping in mind concerns for adjoining habitats and ecosystem, is the prime need.

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