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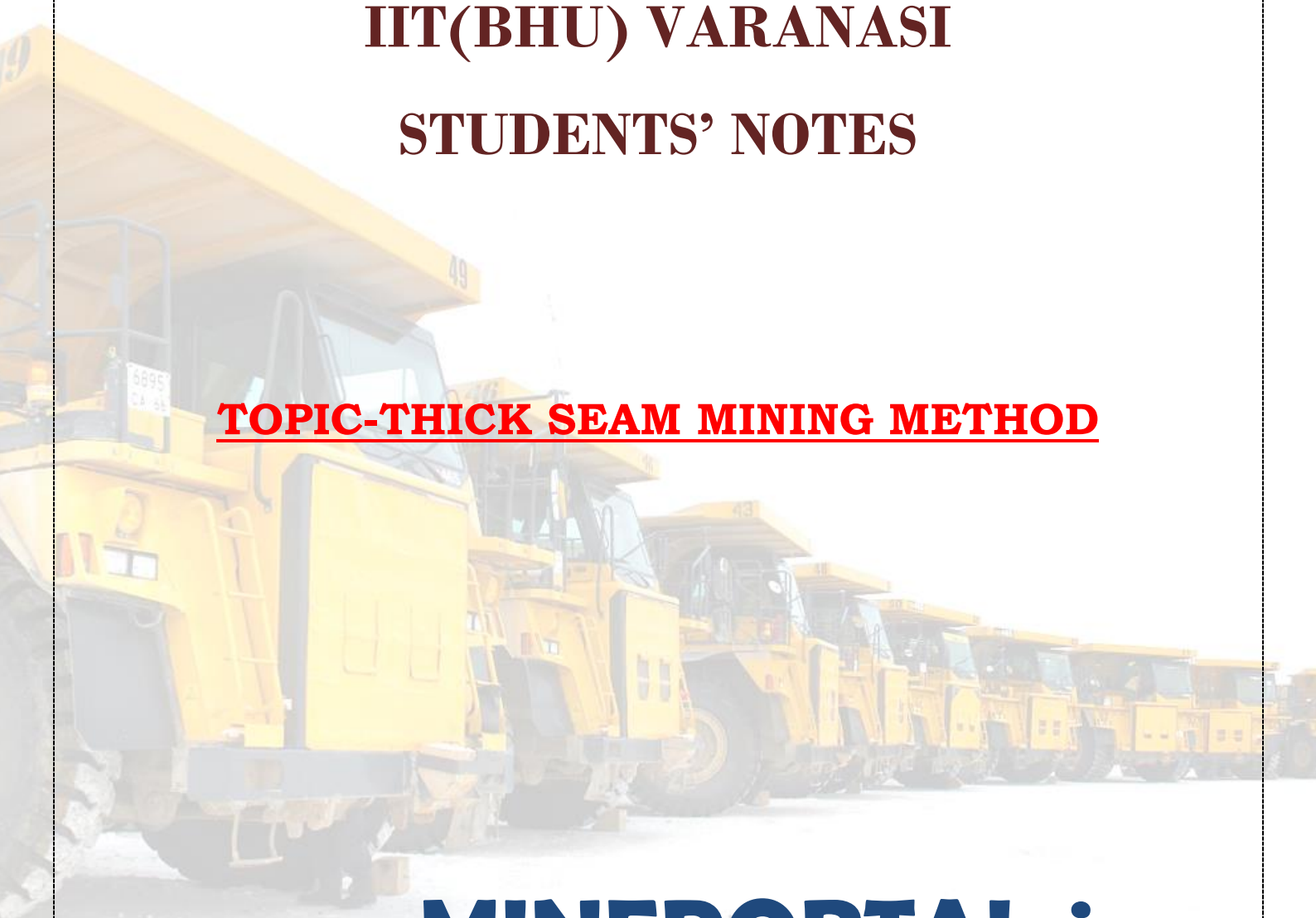
# IIT(BHU) VARANASI

# STUDENTS' NOTES



## TOPIC-THICK SEAM MINING METHOD

3) Roof control problem – Working of a seam in one section requires a support which is capable of sustaining a larger amount of load while maintaining its own stability. Unfortunately the support being used for conventional working doesn't have sufficient axial stiffness mainly because of its light weight nature. Thus making them unsuitable for working of higher thickness. Further it is also observed that larger is the thickness of extraction more is the amount of load induced on the support.
These are the reasons due to which it has not been possible so far to have extraction more than 4.5 m in a single lift ofcource in conventional one.

4) Problem of Ventilation – With increasing volume of coal being disturbed in U/g working, the amount of heat, moisture & gas being liberated from the strata also increases significantly. ∴ the requirement of ventilating air to clear out all these problems increases significantly.
the thick seam is mined in section
Further when ~~it is fixed in a mines~~ simultaneously ~~intersection~~ the ventilating air from one single intake roof is required to be directed to other section of working.

In this procen the leakage of air is ~~ev~~ inevitable and therefore only a portion of ventilating air reaches to the working faces Thus making them hot & uncomfortable ~~for us~~. to work.

5) Problem of transport – Multi-section thick seam working require transport of coal from other sections to a common point in a particular section. Independent transport of coal from individual sections is not possible. Therefore the transport network is complicated and more elaborate in each working section.

6) Problem of supervision & co-ordination b/w working faces - As because the working faces are highly staggered and sometimes they require very close co-ordination, it becomes very difficult to maintain the requirement.

## CLASSIFICATION OF THICK SEAM MINING METHODS -

1) Thick seam mining by B&P method -

a) Non-simultaneous extraction in lifts or sections in ascending order with stowing - In this method a section 3m high is worked along the bottom of the thick seam in conjunction with stowing. Once the extraction of bottom section is over, second section is started over the stowed goaf of the lower section leaving a parting of 0.5 m.

b) Simultaneous extraction in section with stowing - The bottom section is developed along the floor upto 3m height and then entries to the upper section are established and development done in the 2nd section as well. However there is a parting of 3m in b/w the lower section & the upper section. After developing the upper section, both the sections are de-pillared in conjunction with stowing. While depillaring, the extraction height of the 2 sections can be extended upto 4.8 m.

c) In the bottom section the coal seam is developed for 3m using B&P. Once the development is complete, it is depillared with stowing. While depillaring, the extraction height can be extended upto 4.8 m. During the depillaring process, entries into the upper section is taken from the stowed area of the bottom section. The top section is developed & depillared simultaneously for extraction height of 3m (during dev.) extendable upto 4.8 m (during depillaring)

either by stowing or caving. A parting of 0.5 m may be left in b/w two consecutive sections. Further the development of the top section must lie behind the line of extraction of the bottom section.

d) Non-simultaneous extraction in sections in descending order with caving – In this case, a 3m high section is developed along the roof of the thick seam and depillar it with caving. Sufficient time The goaf is left for sufficient time for its stabilization. Now develop & depillar the 2nd, 3rd & further sections using caving method leaving for sufficient time while working the lower section. A parting of 0.5 m may be left in conventional methods.

e) Simultaneous extraction in section with caving – In this case, the line of extraction ~~to~~ between the two sections must lie vertically one above the other. No lead or lag is allowed.

f) Blasting gallery method →

g) Hydraulic Mining method →

Mining of thick seam by Long Wall method –

a) L/W mining in lifts in ascending order with stowing by non simultaneous extraction – In this case, the entire thickness of seam can be extracted in lift with stowing leaving a parting of 0.5m in between 2 successive lift. The extraction height of individual lift is restricted to 3 m

b) L/W mining in lifts in ascending order with caving by simultaneous extraction.

c) L/w mining in descending order with caving by non-simultaneous extraction while leaving the goaf of previous lift to undergo settlement for sufficient time.

d) Multi-lift longwall with simultaneous extraction in descending order with caving in conjunction with artificial roofing.

Sub-level caving, Integral sub level caving, L/w top hole caving.

24/1/13

## Blasting Gallery Method

This method of thick seam mining is a modification of B&P method where development of the seam is done along its floor and the whole thickness of the seam is extracted in single section during the depillaring stage. The method relies on long hole drilling & blasting in conjunction with use of remote control ⇔ LHD for the purpose of blasting in thick seam & loading of coal from the unsecured area respectively. The overlined roof is allowed to cave for feeling the goaf. Thus it is essentially a caving method.

APPLICABILITY -

a) Thickness of the seam should be more than 6m ~~be~~ less than 15m
b) Gradient of the seam " not be " " 1 in 7.
c) Coal seam should not be highly gassy (degree II, III)
d) The overlined roof must be cavable & there should not be any surface ~~restraint~~ constraints.
e) Coal seam should have lower susceptibility to auto oxidation or spontaneous heating should not have soft clay formation. It should
f) The floor of the seam be competent sandstone.

Description of the method -

1) Development phase - During development the coal seam to be extracted is developed along its floor upto 3m on B2 P system forming pillars of adequate size conforming with width of gallery & cover depth. The dev. can be done either in the conventional, mechanized or semi-mechanized manner.

2) Final Extraction - comprises of depillering of developed pillars upto full thickness of the seam in one section with the help of long hole drilling & blasting. The sequence of operation comprises of the following -

a) Splitting of the pillars - The pillar under extraction is splitted in 2 equal parts by driving a level split 3m high Splitting is done with conventional drilling & blasting & loading on chain conveyor using LHD.

b) Depillaring operation starts from the rise most pillar of the panel. and progresses towards the dip following a diagonal line of extraction.

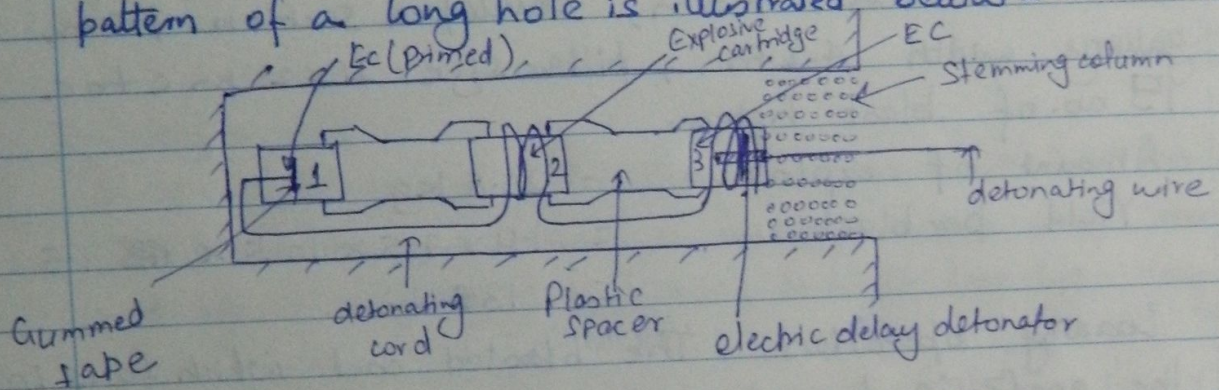
c) Drilling operation → For the purpose of L/W drilling we use electro hydraulic jumbo drills which is capable of drilling holes upto 12m length for the purpose of blasting. Therefore whether a pillar is required to be splitted or not depends on its size. For a pillar less than 25 m wide no splitting is required because the entire width of the pillar can be worked by drilling to its half width from either side.

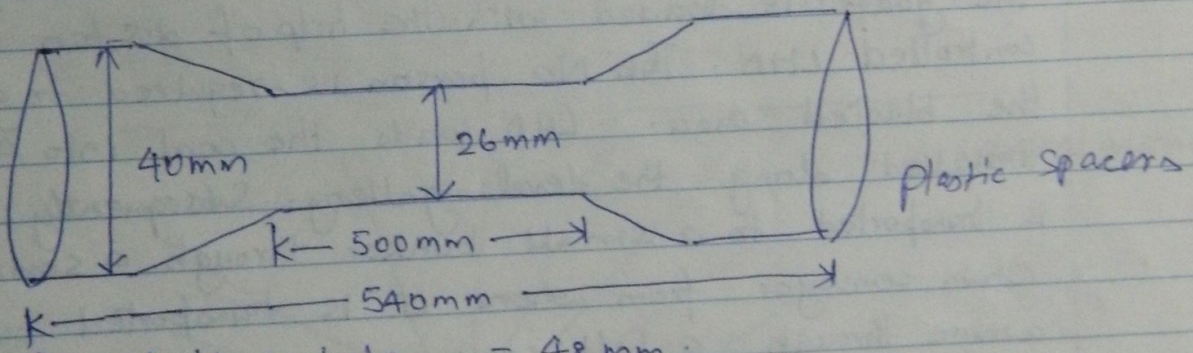
Drilling of the long hole blast holes is made in a ring pattern. In one ring about 20 no. of blast holes 10 on either side of the gallery are generally drilled. The vertical holes are inclined at an angle of 15° towards the goaf side so that the blasted coal is thrown towards the goaf. The total length of drilling in a ring depending on the seam thickness & the pillar size can

vary from 100-160m.

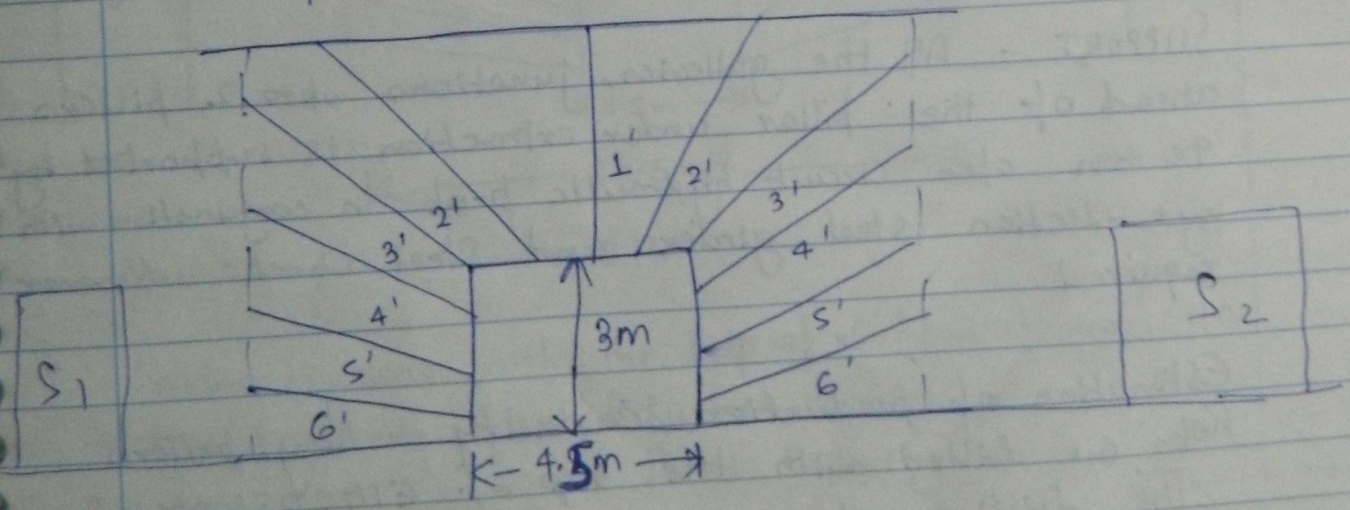
31/1/13

Charging & Blasting — The blast holes are charged with special type of explosive called GE-85 in conjugation with detonating cord, electric delay detonator, plastic spacer and steamming material. The maximum permissible amount of explosive is 2Kg per hole. The charging pattern of a long hole is illustrated below -




Dia. of blast hole = 48 mm.



Seam thickness 7.5m, developed section 7.5m, gallery width 4.2m, pillar size 21x21 m c to c 19 no. of blast holes.

Amount of explosive = 20.8 kg

Yield per blast = 1.4 x 7.5 x 10.5 x 1.5

= 135 ton.

Loading operation - The blasted coal which falls in the goaf is loaded with the help of 2.5 ton remote controlled LHD. No person is required to go into the blasted area. LHD loads the coal into AFC installed along the level gallery. Subsequently the coal is transported to a small bunker through a series of chain conveyor from where it is transported outbye of a mine through a belt conveyor.

SUPPORT - All the galleries, junctions upto 2 pillars ahead of the pillar under extraction is supported by 40 ton open circuit hydraulic prop in conjunction with eye-section steel girders and steel chocks wherever required.

Estimation of production capacity - Ring pattern holes are drilled with the help of EIMCOSICOMA The drilling rate is generally 2m/min including setting of jumbo drill. Therefore for drilling one ring of 90m length @ with avg. drilling rate 2m/min

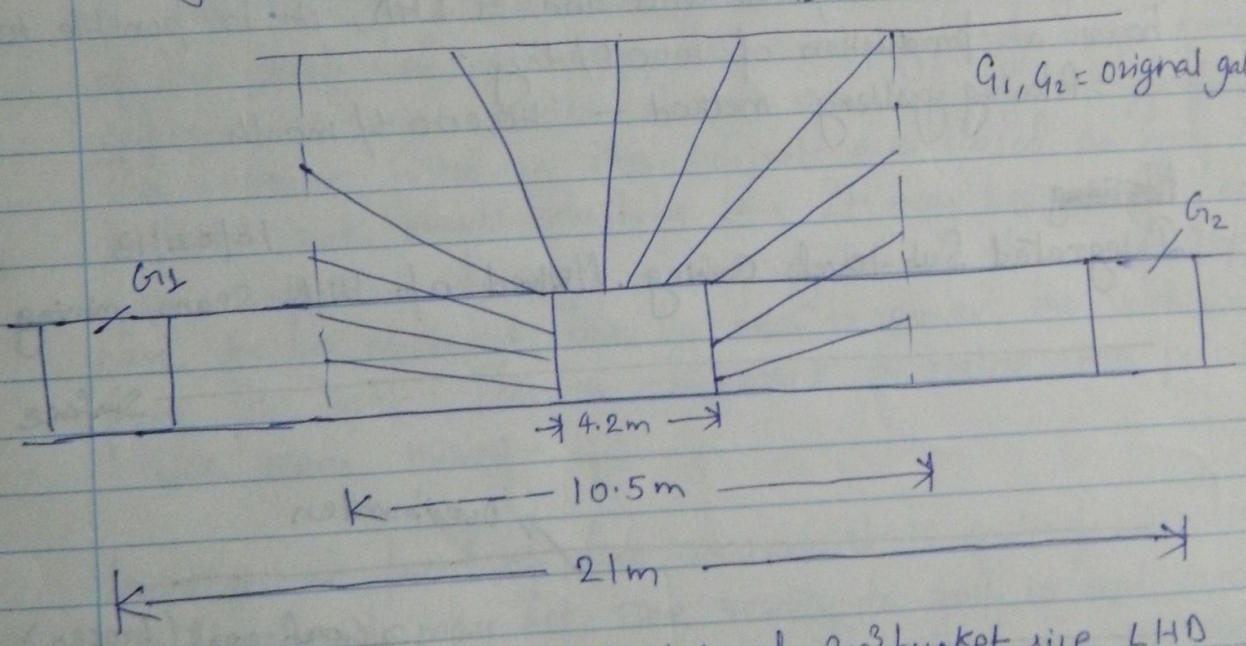
one round will take about 3 hr. ∴ with one jumbo drill, it is possible to have at least 2 ring drilled per shift.

Q) Give a brief outline on technological innovation and operational difficulties ~~in concert~~ encountered in Blasting gallery working in India.

14/02/13

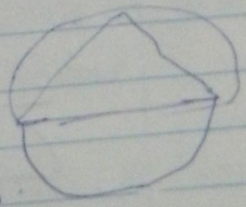
Charging time -
In a ring, charging & blasting operation takes about 2-2.5 hrs time (twice the time as in B&P). Therefore in one shift ~~one~~ with one set of shot fire, it is possible to blast two rings every shift.

Loading time - Yield / blast / ring = 10.5m × 7.5m × 1.4m × 1.5 t/m³
= 135 t

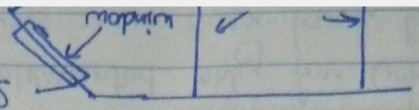



Loading is done with the help of 3m³ bucket size LHD

* ~~Heap capacity~~ Heaped bucket capacity
Liquid filled capacity



3m³ × 1.1 × 0.9 = 2.97 ton ≈ 2.9 ton
1.1 = filling factor of bucket.




→ The average lead distance per LHD with two 90° turns is about 60-80 m. Therefore for average speed of 6 km h$^{-1}$, the hourly capacity is 29-36 ton. Therefore the loading time for one LHD = $\frac{135}{30} \simeq 4\frac{1}{2}$ hours. If we deploy 2 LHD then this can be halfed to 2-2½ hours. Therefore with 2 LHD and one jumbo drill it is ~~The space is ten available~~ possible to have 2 round of blast per shift. Therefore shift wise production is equal to = 135×2 = 270 ton & daily production = 270×3 = 810 t.

→ Machine utilization factor → Considering machine utilisation factor of 0.7, the expected production per day from a blasting gallery panel = $\frac{810}{0.7} \times 0.7 = 567$ t.

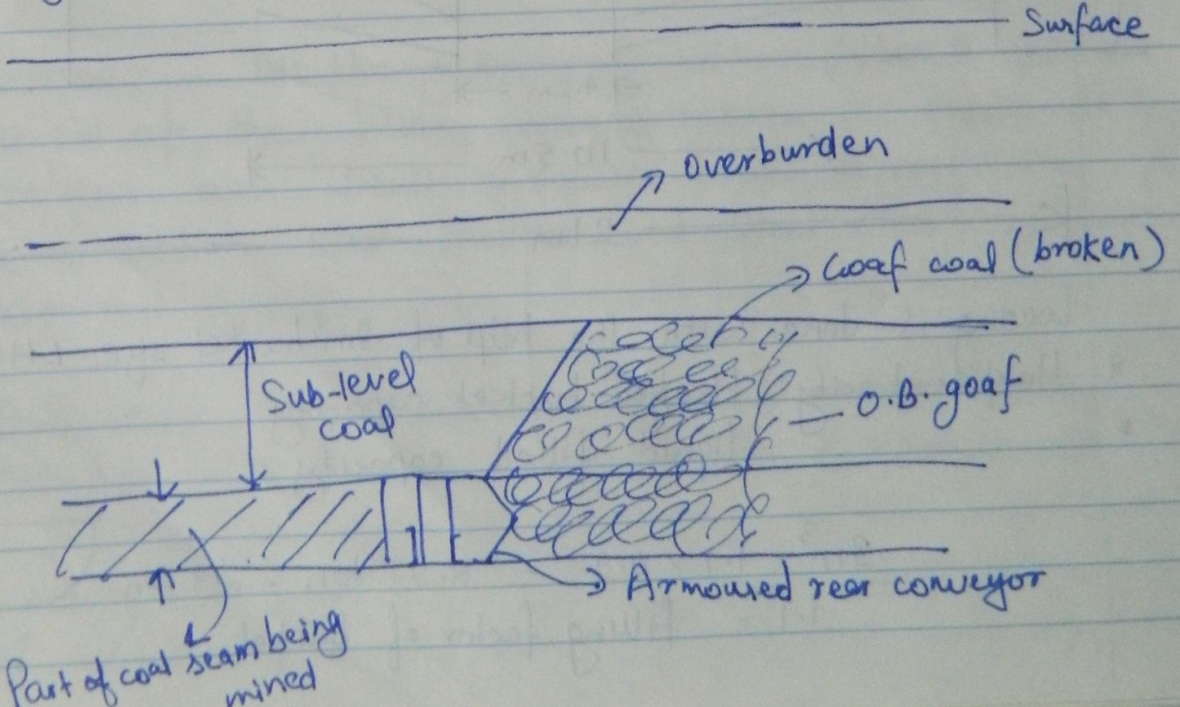
Therefore with 2 jumbo drill and 4 LHD, it is possible to have a production of 1000 t/day.

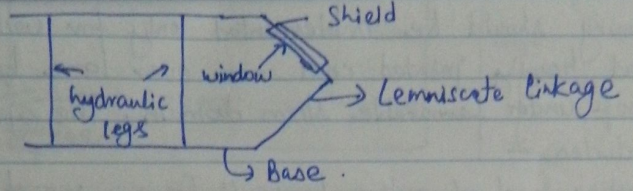
Blasting gallery method — 40,000 t/month

18/02/13

~~Blasting~~

## Integrated Sub-level Caving Method of thick Seam mining

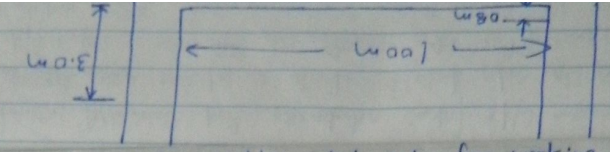





This method of thick seam mining makes use of a l/w face for max. extraction of 3m height to be worked along the floor of the thick seam in conjunction with powered roof support and double ended ranging drum shearer (DERDS). The remaining thickness of the coal is allowed to cave in the goaf with advance of the face. The goaf coal is recovered by activating a window which is controlled hydraulically to allow flow of the broken goaf coal and its subsequent loading on the armoured rear conveyor. The face conveyor which is installed in between the face and the front row of power roof support is used in loading and transport of coal from face obtained from mechanised cutting. As loading of the goaf coal continues the overlying roof start caving to replace the void created due to recovery of the goaf coal. The window fitted in the support are closed as soon as the broken rock starts flushing in. It may be noted here that after completion of every mining cycle all the roof support have to be operated one by one to recover the sub-level coal from the goaf. This is important to realise the potential of thick seam mining.

During initial period of face advance it is quite possible that the sub-level coal may not cave readily to goaf in such cases induced caving may be put in place by blasting of the sub-level coal. Once the natural caving of the sub-level coal initiate its further caving becomes regular as the face advance follow.

Succes of this method relies upon caving characteristics of the coal seam as well as that of overlying roof. This method of thick seam

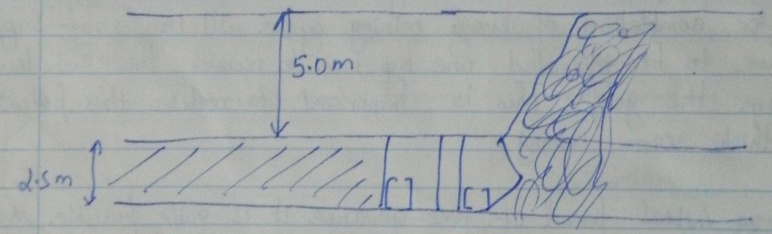


mining should be implemented only for working of weaker and heavily jointed coal seam over lane by easily caving roof under favourable stress domain. The cycle of operation includes —

(a) Cutting coal along the longwall face using shearer either by full face method or half face method.

(b) After completion of every cut along the face under winning of soft coal is done.

Under winning starts from tail gate to main gate supported by shield support. The window is provided at the back shield of the support is open hydraulically using hydraulic ram. As the gate is open coal flow to the armoured rear conveyor. Above the window of the shield hydraulically operated arms are provided which when activated draws the coal from the roof by disturbing the interlocking if any (in the broken coal pile) when the total length of the goaf line is under won the ARC is shifted along with shifting of support.

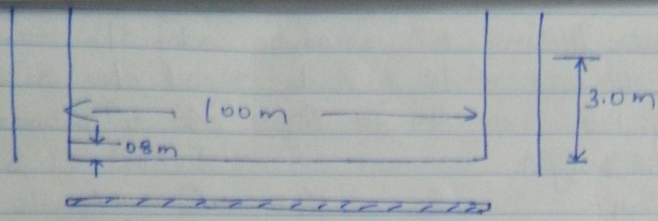



Estimation of production —

length of face = 100 m

Advance per shift / cycle = 0.8 m ( web depth of the shearer)

Mining should be intiemated only for working of weaker




Vol. of coal being cut/cycle

$V_1 = 100 \times 2.5 \times 0.8 = 200\ m^3$

(l) (h) (b)

Vol. of coal obtained from sub-level

$V_2 = 100 \times 5 \times 0.8 \times 0.65$ — Recovery factor

L h B

$V_2 = 260\ m^3$.

Total Volume $= V_1 + V_2 = 200 + 260 = 460\ m^3$

Production per cycle $= V \times 1.4\ t = 460 \times 1.4 = 644\ t$ → Density of coal

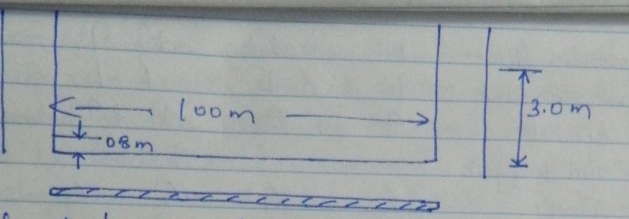
In general mechanised L/W we go for 4 shift each of 6hr 3 shift for production & 1 shift for maintainance.

Production per day $= 3 \times 644\ t = 1932\ t$

Man power Requirement –

| Designation | 1st shift | IInd shift | III | IV | Daily |
|---|---|---|---|---|---|
| Assistant colliary manager | 1 | 1 | 1 | 1 | 4 |
| Under Manager | 1 | 1 | 1 | 1 | 4 |
| Executive engineer | 1 | 1 | 1 | 1 | 4 |
| Overman | 1 | 1 | 1 | 1 | 4 |
| foreman | 1 | 1 | 1 | 1 | 4 |
| Mining Sardar | 1 | 1 | | | |
| Shearer operation + helper | (1+1) | (1+1) | (1+1) | (1+1) | 8 |
| Chock (support) operator (100/1.5+2)=70 | 4 | 4 | 4 | 4 | 16 |

mining should be implemented only for working of weaker and heavily jointed coal seam over lone by easily caving roof under favourable strata depth. The cycle of operation includes —

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| Chock (support) operator (100/1.5+2) = 70 | 4 | 4 | 4 | 4 | 16 |

| | | | | | |
|---|---|---|---|---|---|
| Hydraulic filler | 1 | 1 | 1 | 1 | 4 |
| Drive head attendant | 1 | 1 | 1 | 1 | 4 |
| Heavy tyndal | 4 | 4 | 4 | 4 | 16 |
| Main gate and tail gate support gang. | 6 | 6 | 6 | 6 | 24 |
| Conveyor cleaner | 3 | 3 | 3 | 0 | 9 |
| Haulage operator | 1 | 1 | 1 | 1 | 4 |
| Electrical & mechanical filler | (1+1) | (1+1) | (1+1) | (1+1) | 8 |
| Filler helper | (1+1) | (1+1) | (1+1) | (1+1) | 8 |
| Cyrad | 1 | 1 | 1 | 1 | 4 |
| | | | | Total = | 133 |

$$OMS = \frac{1932}{133} = 14.2$$

Sub-level caving –

Integrated Sub level caving experienced in East Kotras Colliery, Jharia Coalfield.

In this method thick seam is worked by having a lower L/w face being worked along the floor and upper L/w face being worked along the roof and the sub-level coal being recovered using the similar mechanism as in the case of integrated sub-level caving. This method is useful for working of those seam having thickness more than 9m but upto 15m.

The working of L/w face is required to ensure –

(i) Smoother caving of sub level coal
(ii) providing an undercut between the rock & coal surface so as to achieve a better contrast of differential caving (b/w that of rock and the coal).
(iii) Improving the overall recovery
(iv) Minimising the dilution.

The upper L/w face is required to lead the lower L/w as

Hydraulic fitter | | | | Drive head attendant

the lower L/W face advances the sublevel coal caves in due to its own weight which is under won through the window provided at the shield of the roof support. The under won coal is loaded on the armoured rear conveyor (ARC) place along the face along its goaf side. In this case the thickness of sub-level coal may be upto 10m. The recovery of sub level coal in this case may be upto 70%. Both top & bottom L/W is worked by deploying shearer and power roof support. In a few cases the top L/W has also been worked as individual support L/W however such a condition of face deployment is not advisible due to their significant mismatch.

07/03/13

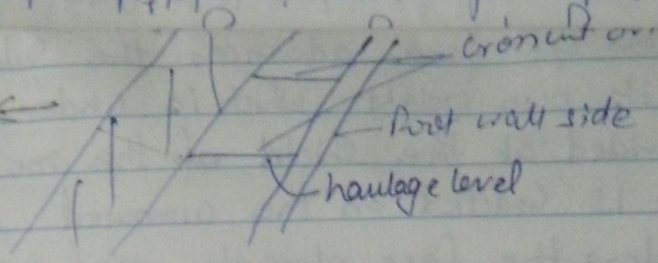
Multi-slicing using wire ropes with artificial roofing

Mining of thick and steep coal seam -

Method of Development -

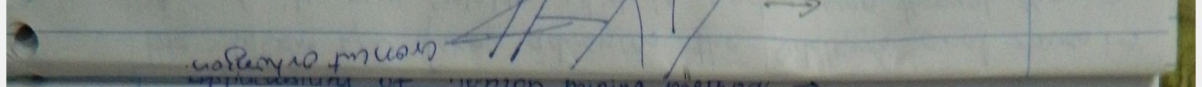
- Horizon mining method → This is a method to establish areas to steeply inclined coal seam or a group of such coal seams occurring in close proximity and developing it. In this system of approach all the preparatory working like main haulage roots, ventilation roots are driven along level in the country rock from the bottom of the shaft so as to reach the coal seam at a particular horizon providing the best method of transport

Horizon System of mining → This system consist of driving a vertical or inclined shaft from suface to a point some distance below the seam or seams or the intended depth of working. The depth upto which the shafts are sunk below the seam to be worked is infact dependent upon the depth and the dip of the seam. The shafts are generally driven on the foot-wall side of the coal seam.




From the shaft at least a pair of levels in rock called horizon or cross cut are driven at 2 different horizons. The lower intake cross cut or horizon driven from the ~~entry~~ and the ~~return~~ return shaft is called haulage level/horizon. The upper horizon called ventilation level is driven from the U/C as well as the d/c shaft. This cross cuts are driven horizontally from the shaft so as to reach the coal seam either at right angle or at certain other angle in the strike dir$^{n}$ of coal seam. At the cross cuts driven at 2 different horizons touch the coal seam in its foot wall side coal laterals along the floor of the seam are driven following the strike direction of the seam. These coal laterals are called levels. These levels are connected by driving upward roadways called Raise at particular interval thus forming block of coal bounded by two coal laterals and 2 raises. The dis. b/w 2 consecutive coal laterals i.e. 2 horizons is generally kept as 100 m along vertical. The dis. b/w the 2 consecutive raises is generally kept as 80-100 m. The driving of coal laterals starts from the entry point of the seam and is extended towards boundry thus forming blocks of coal upto the boundry which are extracted either by inclined slicing or horizontal slicing.

After completion of all coal b/w the 2 levels ~~from~~ 3rd horizon is driven at higher depth. When a no. of coal seams exist in close proximity the same prospects are extended reaching each seam in succession. The optimum horizon interval is determined on the basis of different variables like development cost/ton of coal produced, thickness of seam, density of the seam and the method of mining.



Applicability of horizon mining method →

Horizon system of mining is adopted under following condition –

(a) When the seam density is high
(b) The gradient of the seam > 20° where other methods of development are not usefull.
(c) The seams are disturbed by geological disturbances.
(d) Where the maintainance of the main road in the seam is different
(e) Where the requirement is there for high prod$^n$
(f) for working of seam occurying at high depth

Advantages and Disadvantages –

(a) It provides the main roads for efficient and adaptable haulage system. In general locomotive haulage is used in its most efficient form capable of dealing with high output in the order of 3000 t/day.
(b) It makes possible a highly efficient ventilation system due to presence of 2 seperate & independent roadways intake & return without the possibility of any air loss or short circuit.
(c) Maintainance cost of the roadways is negligible.
(d) It is easy to work several coal seams at a time.
(e) It is eminently suited for inclined & disturbed seam

Dis –

(1) It requires high capital expenditure for development work which can only be justified if higher rate of production with greater overall efficiency can be achieved.
(2) It takes much longer time till a mine can achieve its target production.
(3) For lower seam density, the method is not profitable

Extraction of thick & steep coal seam -

Using inclined slicing method in ascending order with stowing -

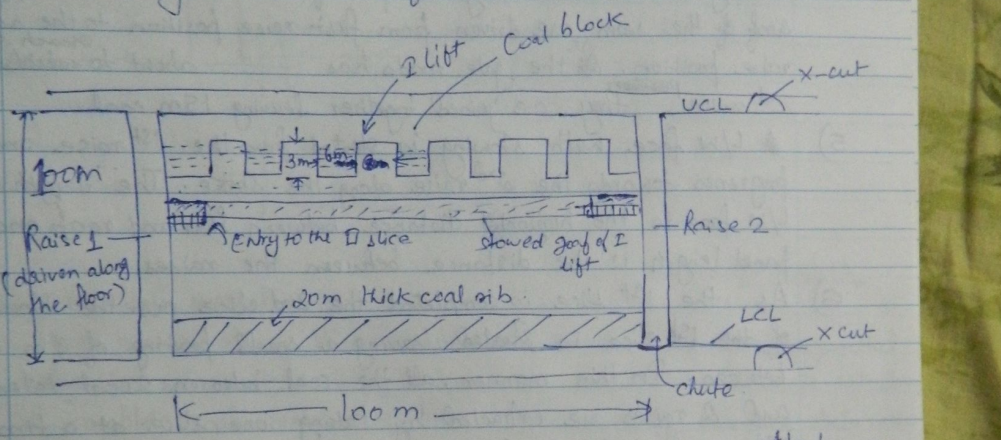
In this method, the thick and steep seams are generally approached by horizon system of mining where two horizons called Upper horizon and lower horizon are driven from the staff level in the strata so as to reach the coal seam in its footwall side. As the seam is reached coal laterals along the flow of the seam are driven following the strike direction. The coal lateral in the upper & lower horizons are connected by driving raises at an interval of 100m thus forming a block of coal of size equal to 100m × 100m × thickness of the seam. This block is extracted using inclined slicing method starting from the lower horizon to the upper horizon in L/w fashion.

For this purpose, a L/w face is opened along the flow of the seam in between the 2 raises connecting upper & lower coal laterals leaving a sill of 20m coal from the lower horizon. The L/w face is ~~left~~ dead along the strike of the seam & it advances from dip to rise i.e. from the lower level to the upper level. It may be noted here that due to steep gradient of the seam it is not possible to use the pushing mechanism of AFC. Therefore powered support are not used in this case. Therefore the L/w face is extracted with conventional drilling & blasting technique forming a stable at regular intervals in conjunction with stowing using individual supports. The blasted coal automatically rolls down to conveyor however little amount of shoveling may also be required sometimes. The conveyor discharges coal onto one of the raise in which steel flumes are fed. At the lower level coal lateral the coal is loaded into mine car through wooden or ~~iron~~ timber chute provided just above the coal lateral.

When the 1st slice/section is advanced by 25m or so, the 2nd slice above the ~~stowed~~ stowed goaf of the 1st slice is started leaving a parting of 30cm. ~~Entry~~ Entry to the 2nd lift is taken from the raises provided along the flow of the seam. In this way several lift can be worked one after the another simultaneously. In India

Extraction of thick & steep coal seam -
Using inclined slicing method in ascending order with stowing -
In this method the thick coal seam

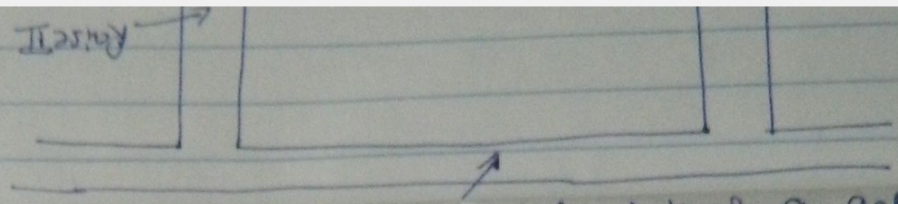
we have been succesful to extract a max of 5 lifts from single opening raises.
When one block is extracted the extraction of next block is started.
Working of the blocks are generally done in retreat fashion starting from boundary towards the shaft.




20/3/2013

Working of thick and steep coal seams by Horizontal Slicing method →
This method is applicable for working of thick (more than 20m) and steep (>30°) coal seam. The method consist of extraction of the seam in slices in ascending order with stowing. These slices consist of a L/W face laid on a horizontal pattern from floor to roof of the seam. The system of development & working in horizontal slicing method is as below -

1) The steep seam is approached along the floor of the seam from two different horizons by driving cross cuts using horizon system of mining.
2) From upper & lower horizons, coal laterals are driven along the floor of the seam following its strike direction.
3) These coal laterals are connected together by driving raises at an interval of 60-100m. Thus forming block of coal of size (100-150m) × (60-100m) × thickness of the seam.



4) Leaving 15m coal from the lower coal lateral a gallery of 4.5m width & 2.5m height is driven from the first raise across the seam i.e. from the floor of the seam to roof of the seam in a horizontal plane.
Two gate roads one along the floor of the seam & another along the roof of the seam are driven from first raise position to the second raise position. As the gate roads has reach the 2nd raise position they are joined together leaving 15m coal. ~~about to~~

5) A L/W face with stowing is started from the 1st raise and it progresses towards the 2nd raise along the strike. The length of the L/W face is the horizontal distance between floor and roof and the panel length is the distance between the raises.

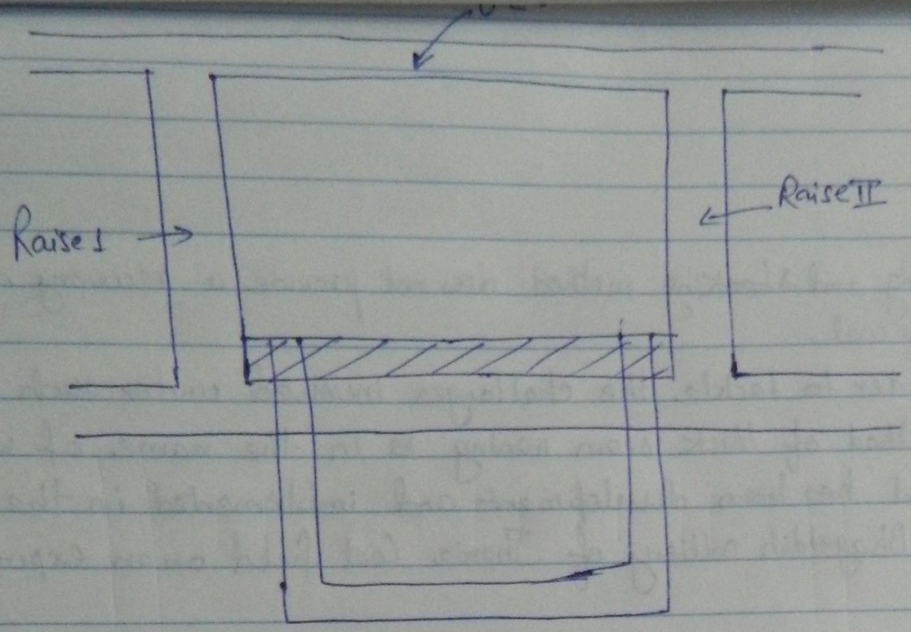
6) As the 1st slice is completed the 2nd slice over the stowed goaf of the 1st slice is started leaving a small parting of 1m in between. In this manner, all the coal between 2 coal laterals and 2 raises are extracted by taking one slice at a time.

→ The major problem of the system is the shrinkage of sand. This method have been applied in Turamdih mine for extraction of a max. of 5 slices in any blocks. It has not been possible to work further slices due to fracture of floor coal caused by shrinkage of the filling material.

→ ~~Compact fill replacing hydraulic sand stowing~~

Extracted coal = 2.5 × 5 = 12.5 m
Parting coal = 5 × 1 = 5 m
Total = 17.5 m

Russian have suggested of compact fill replacing hydraulic sand stowing.




4/04/2013

Wide-Stall method →

This is a method of thick seam mining based on concept of partial extraction where it is not ~~po~~ possible or allowable to facilitate extraction of complete coal seams at the cost of damage of overlying strata under sensitive surface structure. In a no. of mining areas, extraction of coal seams at shallow depth of cover has not been possible due to built up surface structure [Road, railway line, river, overhead power supply etc..]. In this situations a large amount of coal is locked inside the panel as support so as to ensure stability of overlying strata.

Under such condition the conventional method of mining for optimal coal extraction is to have partial extraction by spliting and stooking of the pillar. The formation of stook during the optimisation of recovery causes a considerable draw in the strength of natural pillar which is not desirable for long term stability of U/g mining and surface structure.

A more difficult situation arises during optimization of recovery from a multi-section developed thick coal seam where additional problem like decrease of pillar strength due to increase extraction height, instability of parting and super imposition of pillars. These problems make the situation more complex from production, productivity and safety point of view. For Indian Geo-mining condition has been found that conventional

Splitting and stooking method does not provide a recovery more than 30% of coal.

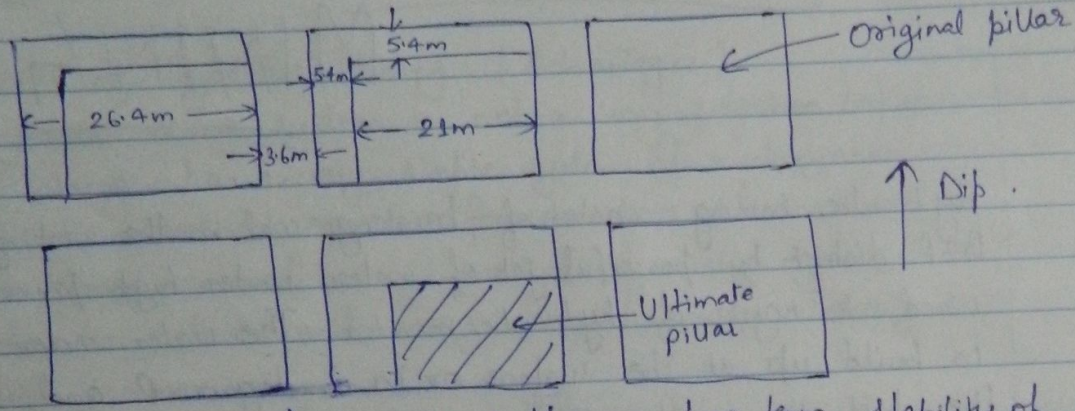
In order to tackle the challanges involved under such condition a method of thick seam mining in the name of wide stall method has been development and implemented in the field of East Bhagatdih colliery of Jharia Coal field on an experimental basis.

The mine adopted this method to extract two coal seam i.e. in Ⅹ of 9.5m thick and lower seam Ⅹ 7.5m thick having intervaning parting of 7m in between at a cover depth of 120-180m. The method of wide stall considers that the size of the gallery upto which original gallery could be widen should be orationalized entune with the strength of immediate roof & floor of the natural supp--ort by increasing w/h ratio. The strength of ultimate pillar and the stability of overlying ~~exposure~~ exposed roof span both play an important role for long term stability of the surface structure at shallow depth of cover.

The conception is that the effective bearing capacity of the pillar should be comparatively more as compare to no. of stook of eq -uivalent area.

11/04/2013
Thursday

## System of Wide and Stall mining




As the method of mining emphesases long term stability of the ultimate pillar as well as intactnen of the roof in the widened galleries, it is important to ensure a proper mining system to meet this 2 basic objectives.

In the mine under study the size of the original pillar was 26.4 m x 26.4m whereas the gallary width was 3.6m. The amount of recovery during development was about 7% for 12m thick seam. The seam was developed in three number of sections which was having a shell band of 0.6m thicknen at a height of 3.6m, 7.8m and 10.5m. Taking advantage of the presence of the shale ~~shell~~ band the working section of the individual slices were suitably planned. In a particular slice for depillaring of the pillars, the original galleries of 3.6m were widened upto ~~8.4m~~ 9m by driving additional galleries of 2.7m in 2 stages. The size of the ultimate pillars left in the goaf was 21m. The coal roof with intact rock tensile strength of 2.5 MPa was found to be sufficient to maintain a long term stability for 9m wide gallery; however when the subsequent section are also work out, the ~~w/h~~ ratio of the pillars in unfavourably shifted to have a non-stable characteristic. Therefore in all the working sections, hydraulic sand stowing was done to fill the widened galleries upto 60% of the extraction height to increase the effective confinment of the ultimate pillars resulting in overall improvement in their stability.

# HYDRAULIC MINING

Hydraulic mining consist of breaking coal in the working faces of B&P district by powerful jet of water under high prenure deli-vered to nozzle of hydraulic monitor. The water under prenure is build up at the surface or in underground and is fed to the hydraulic monitor. The outlet jet of the monitor is directed towards the coal face which causes primary and secondary fracturing of the coal from the coal pillar. The coal so dis on the pillar is adequatly fragmented and get mixed with water. The water coal mixture is transported to through the transport roadway specialy prepared under gravity.

Applicability condn –

(1) For hydraulic mining it is very important that the strength of coal to be worked should be low.

(2) The effective prenure of water must be higher than the strength of the coal.

(3) For all practical purpose, the strength of coal should be len than 20 MPa that can be effectively cut with water prenure of 400 bar.

(2) The roof should be suffiiently strong to allow coal to be extracted under heat prior to its collapse.

(3) The thicknen of the seam should be high. It is ponible to extract 15 m thick seam in 1 section by hydraulic mining method.

(4) The gradient of the seam should be sufficiently high to allow smoo-th flow of coal and water mixture by gravity.
A gradient of 7° in favour of the floor is sufficient for this purpose.

However hydraulic tranport is possible at a gradient of 1 in 40 by putting theme boxes along the transport roadways.

(5) Sufficient amount of water must be available near the site.

Merits of Hydraulic Mining (Advantages)

1) Hydraulic mining system is not a very ~~so~~ sophesticated method of mining, has a very simple system of mechanization, requires very low ~~tech~~ technical exposure for execution of the working. The machines used in this method of mining (pump, h.m.) are very robuus in nature and, hardly any undergo breakdown ~~on~~. Thereby their availability is maximum.

2) Operational and capital cost is low as tranport is done by water with the help of gravity. (len manpower deployment, len support)

3) ~~The~~ len chances of explosion due to simplified ventilation & reduced use of elechrical power.

4) The operator of hydraulic monitor stands away from the cutting front therefore no immediate support requirement is there in the working faces.

5) The efficiency of the labour is very high and the productivity also is quite high.

Demerits →

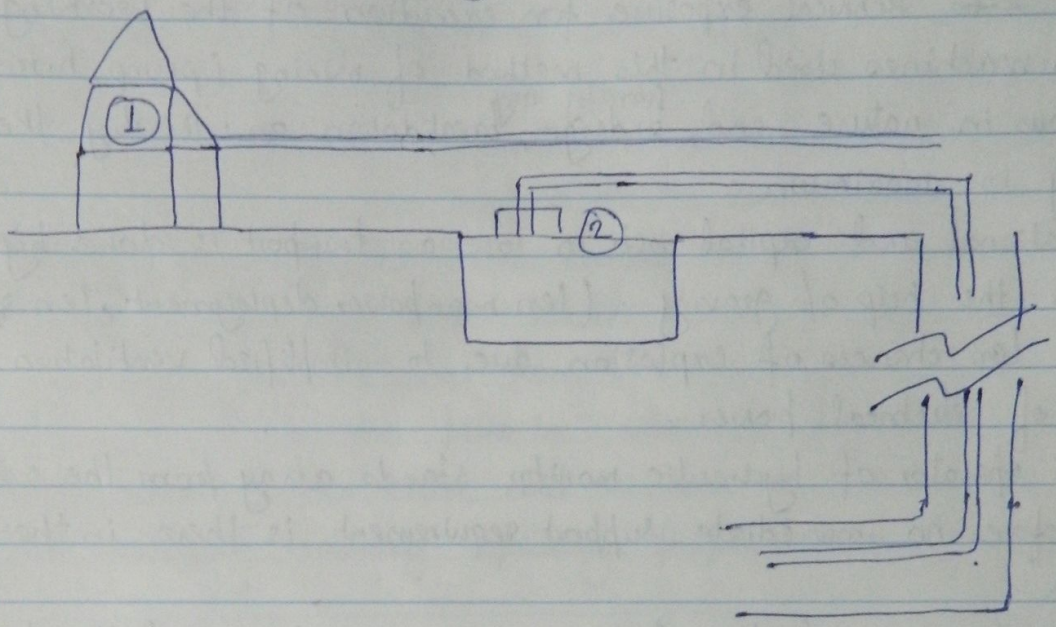
(1) Hydraulic mining ~~sta~~ system consumes more power as compared to conventional power consumption (about 2.5 times more)

(2) The working condition in u/g is very uncomfortable due to high humidity.

(3) Considerable loss of coal in the faces.

(4) Problem of large size coal lumps.

Flow sheet for U/g Hydrolicking




1. Dewatering plant.
2. High pressure water pump.
3. Production face.
4. Hydraulic monitor.
5. Coal transporting trough.
6. " " "
7. Pulp line
8. Coal ~~the~~ sucker / pulp pump.
9. Pulp collector
10. crusher.

In a modern all the operation related to winning of the coal & its transport upto the surface is

The transport of coal is done by means of specially manufactured high pressure coal suckers operating at water gauge of 120-170 m. Coal is broken with a thick water jet which is issued from a hydraulic monitor installed at some distance away from the face (3). Fractured and fissured coal seam are very suitable

. Some of the fractures are natural whereas some others are created by the dynamic interaction b/w the coal and the water

. Water under pressure penetrate into the existing breaks off coal pieces from the coal mass and finally the broken coal pieces along with water gravitates along broken flumes-ded in a

. The pulp of coal & water is collected by the above collector to a crusher tank. In this process the coal & water mixture from all the development faces of working is collected. The function of the crusher is to reduce the lump size of coal to -70mm suitable for

. The coal collected at the bottom of the coal collector is then sucked using coal sucker by a pipeline to the surface. On the surface there is facility of coal concentrating mill where the coal undergoes drening, concentration, dewatering and drying up processes. The clear water is recycled and fed back to the pump section

high pressure pump and from this to the hydraulic monitor (4).

Method of Mining → In hydraulic winning of coal, the mining area is divided in 2 panels. The panel development is usually suitable for flat coal seam formation with significant dimension along the strike. In order that the pulp of coal & water gravitates from the faces to the shaft bottom all development working within the mining area are given a gradient of atleast 5° in favour of the flow and the is divided into rise panels. The

Main haulage and ventilation gate roads are driven from the shaft bottom to the boundaries with a rising gradient of 5°. Panel ~~for the~~ haulage roads and panel roads are driven to the full in middle of the panel. Some panel haulage and some panel ventilation ~~gate~~ are driven from panel rises to the bounday of the panel at a gradient of 5°. ~~With~~ These gate roads are about 150-200 m apart.

System of depillaring → for depillaring of flat coal seam, hydraulic mining can be used with certain ~~rectifica~~ modification in B & P system where the main transport gate roads and the main ventilation gate roads are driven . The ~~intake~~ intake rise and return rise are driven towards the full rise. These rise galleries are interconnected by an accumulator gallery and panel return heading. After developing is completed, extraction rises are driven from the gallery at every 20m to join the panel . The main characteristic of coal winning process during depillaring are as follows-

① The coal is won without timbering in the productive face. The coal is broken by water from same distance

② The dimension of the coal face depends on effective ~~range~~ length of hydromonitor

③ Coal is transported ~~to~~ during section
for this purpose the development working must be driven in a certain (min. of 5°) towards ~~to Wash~~ the sump of the coal & pump.

Water consumption in winning of coal =
for depillaring area water consumption = 5-6 $m^3$/ton.
Hydro energy requirement = 10kwh (10 units)/ton of coal for hard & massive coal & 5kwh/ton of coal for soft and coal.

Hydro monitor capacity

$$A = \frac{QP}{36.7E} K$$ where,

A = monitor capacity
Q = water consumption $m^3/hr$.
K = coefficient 1.8 → depillaring and
1 → development headings
P = hydraulic prenure
Pmin = 50f
E = energy

Books –

Coal mining practise – R.D. Singh

U/G coal mining by – J.D. Singh

Advanced coal mining by – Borov Jovand Deshmukh (Vol. II)

## Stipulation of Stress Concentration –

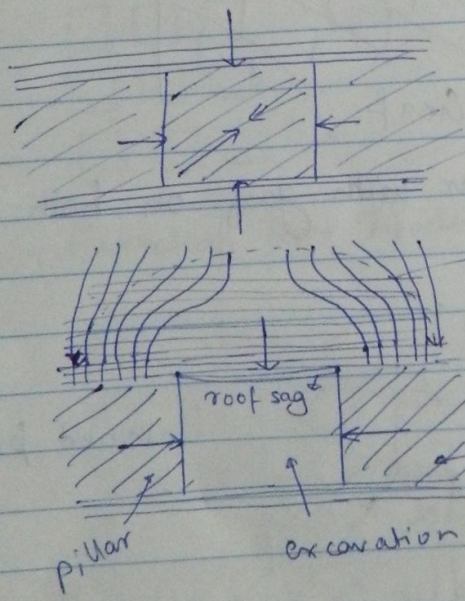
Redistribution of equilibrium state of stress such that certain regions are heavily loaded whereas certain regions are completly deloaded from the stresses. This is because of change in equilibrium state of stress in rockmass.

Stress superimposion – Stresses mutually superimpose each other. Stress conc. may be again due to stress superimposition.

U/G excavation
- Narrow excavation (gate roads)
- Wide excavation

Because of intense loading, adjoining pillars will fail.

11/01/13




Static equilibrium
(No unbalanced force)

Support will not take care of stress distribution. Provide reaction to the movement of roof.

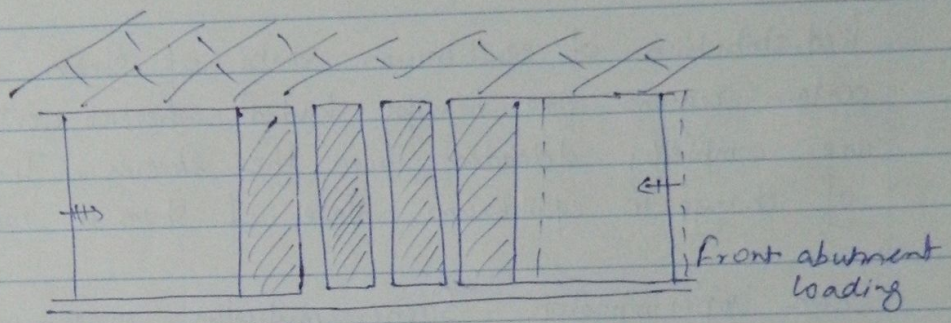
Filling with Sand, cave fragment is a massive support.

Diff. b/w Stress superimposition & stress concentration

16/1/13

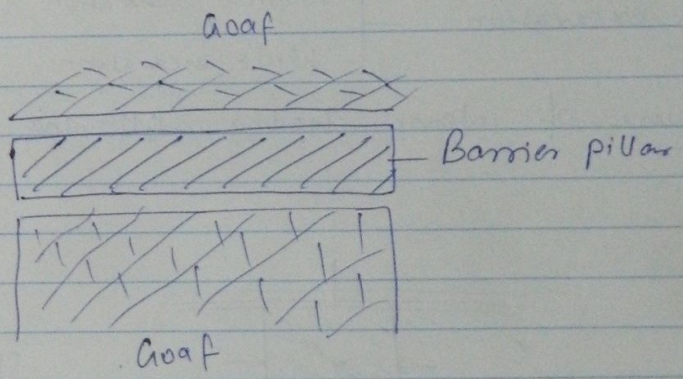
Situation of Stress concentration –

1)



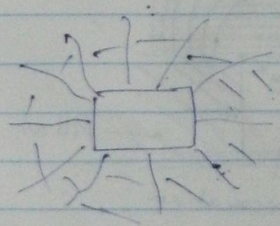

Extn. fronts movement

2)



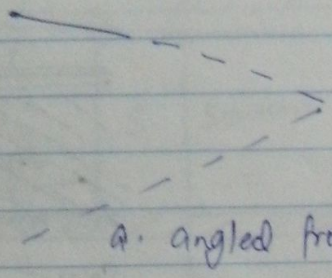

Narrow barrier pillar with goaf on both sides.

3)



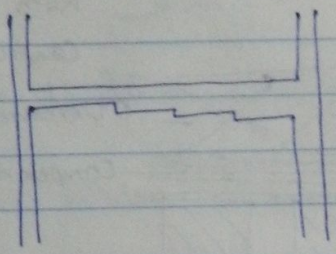
Unmined pillar inside goaf

4) Angles and discontinuities on extraction face:



a. angled front

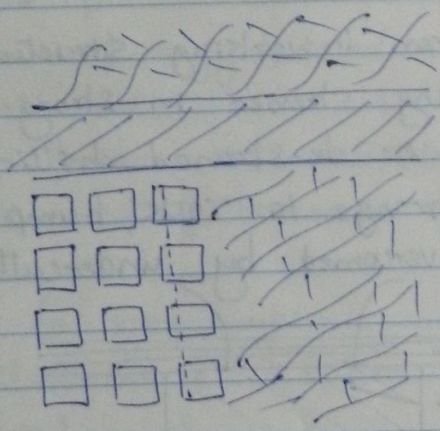
Angled ext. fron are liable to fail under high shear concent$^n$.



b. discontinuous extraction front.

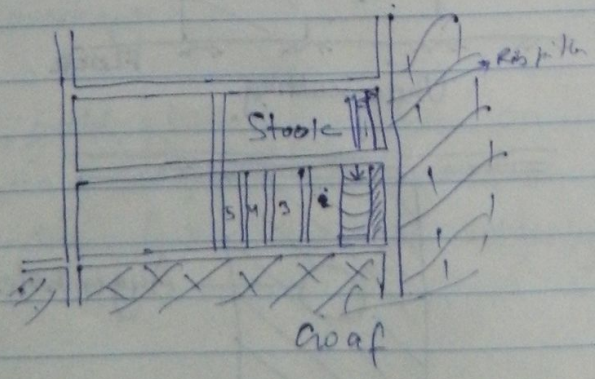
Try to maintain as straight face as possible. complete cycle should be finished in 1 shift.

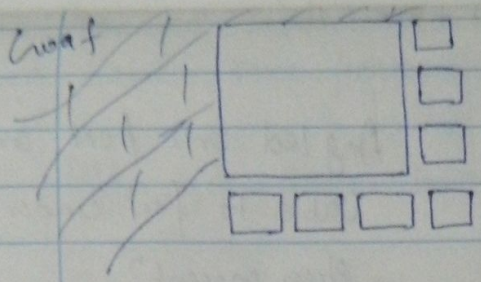
5.

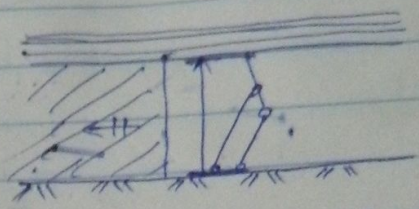


Extraction front heading towards a gallary

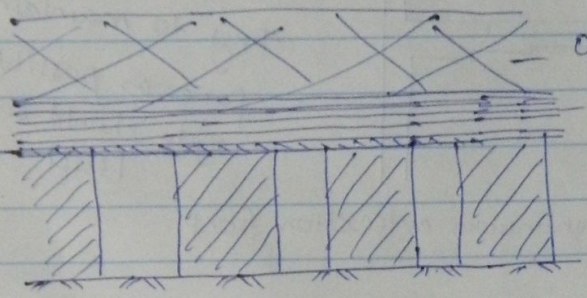
6.







Section showing L/W face with strong and massive cantilever in roof



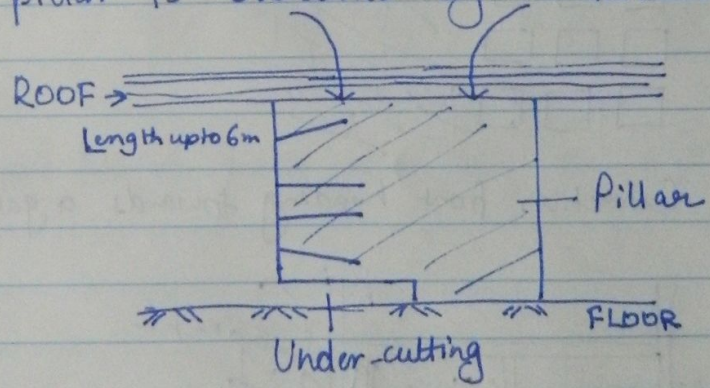

23/01/13

How to relax stress in working structure.

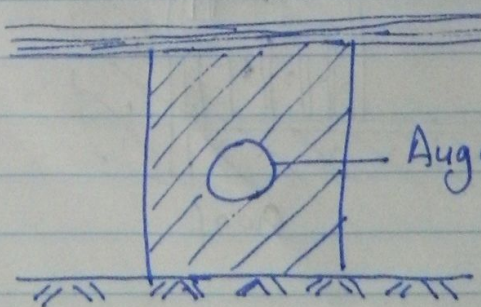
Method of releasing stresses in strong massive Cantilever roof

a) Induce Blasting or de-stressed drilling. dia - 32-40 mm

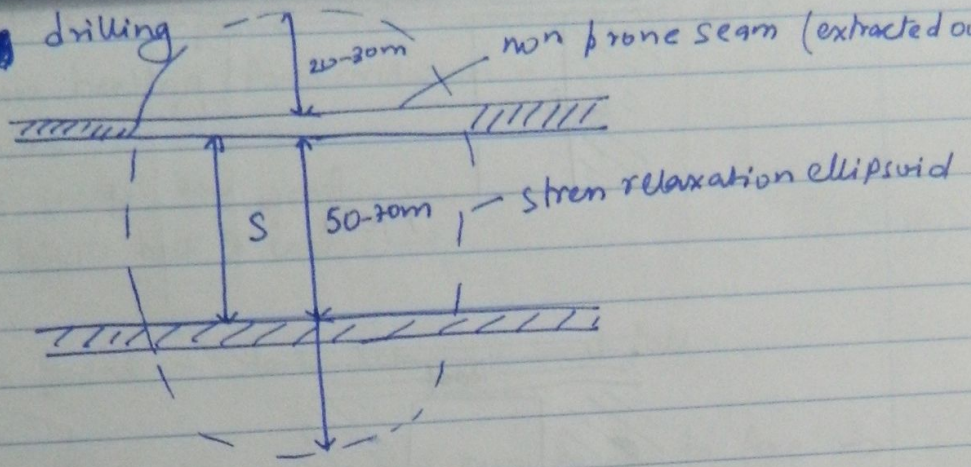
If a seam is prone to rock bump - stress concentration in pillar is overcomed by undercutting.




Height of undercut - 5cm



→ De-stressing drilling




Stagger – 2S or 30 m whichever is more.

→ Thinning of the pillar also used as a technique for stress relaxation.

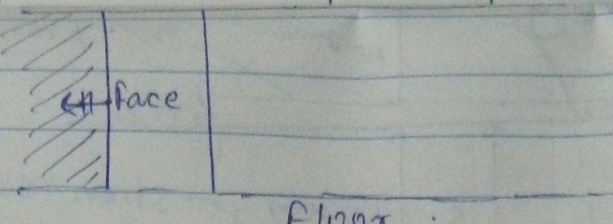
30/1/13

Winning of Seams prone to rock bumps →
Sudden & violent failure of rock / coal, - rock bumps.
→ with huge amount of energy released in small time. It may be localised or extensive.
In coal mines pillars are subjected to release of sudden energy & failure of pillar occur.

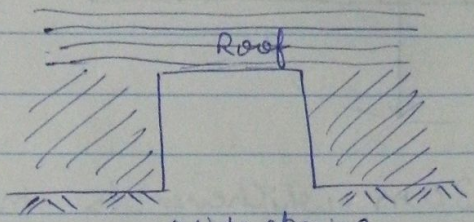
Possible reason for rock bumps –

a) Depth of coal seam – > 300m.
b) Nature of coal.
c) Abutment loading
d) Large roof overhangs.

b) Soft, friable / yielding pillar - destress on its own
hard & elastic - keep on storing strain energy without giving sign of impending failure but fail suddenly.
d) ~~As~~




Uncontrolled caving.




wide opening (unsupported)

How to control Rock bump –

1) Shen Relaxation –

→ We should use such method of working which eliminate too many entries.

Chain pillars / Solid barrier pillar → Go for solid b.p.

Chain pillar / Solid b.p. / Strip pack → go for strip pack.

→ Induce Caving in immediate roof.

→ Full caving of the " " and part caving of main roof

→

Signs of Rock bump –

→ Sharp loud noise

→ Huge amount of coal ~~dismon~~ dismantled from face.

→ Ground surrounding the coal seam will shake.

→ Supports may be ejected / thrown off.

→ Belt conveyor & face equipment may be thrown off even powered support get dislaged.

→ Occurance of air blast