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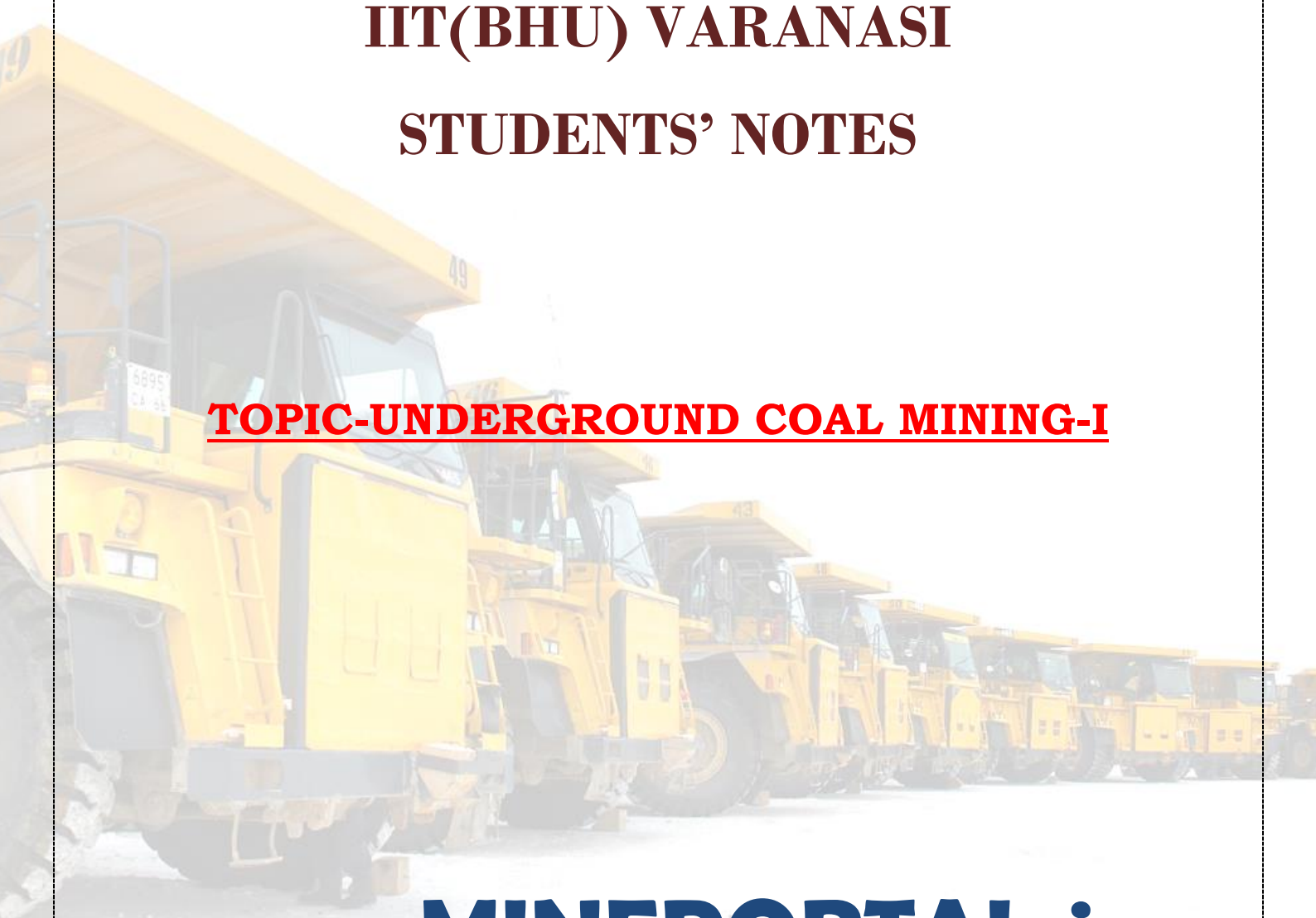
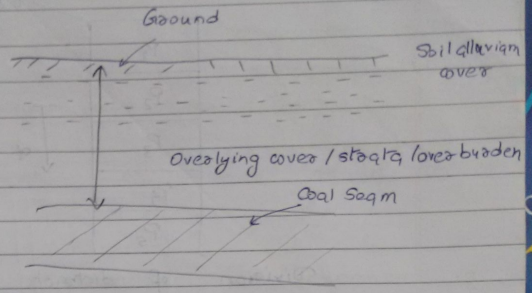
IIT(BHU) VARANASI

STUDENTS' NOTES



TOPIC-UNDERGROUND COAL MINING-I

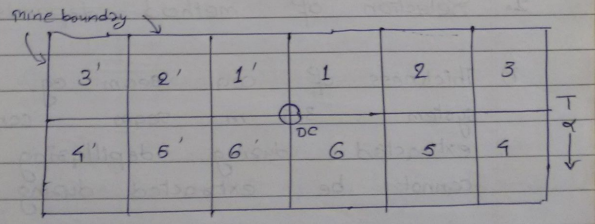
Ulg coal mining



Z = 100m, 200m
300m, 400m

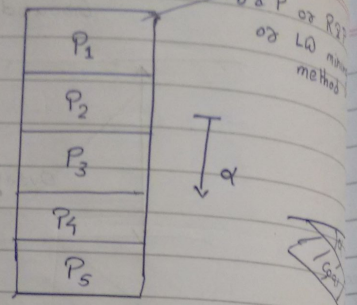
Thickness
- < 1.5 thin
- 1.5 - 3.5 moderate
- > 3.5 thick

1. Division of mining area



Plan showing division of a coal mining area into district

Slaughter mining → Overlooking of rules & wherever and whenever system



Division of district into uni-lateral plans

First district is extracted 1-1', 2-2', 3-3', 4-4', 5-5' and 6-6' and then district is divided into panels

Panels are also extracted in a sequence manner

1. Selection of method depends on

i) Thickness of coal seam eg B&P system, 3.5 m seam can be extracted during depillaring and cannot be extracted during development

ii) Inclination of coal seam and the problem is manpower stability and water runoff

iii) Nature of coal seam as cutting is possible in soft coal but blasting for hard rock.

iv) Uniformity of rock as if it is not uniform

v) Size of deposit as expense is less in limited deposit

vi) Presence of water in coal seam.

vii) Nature of overburden, roof and floor

Panel - Smallest unit of coal mining

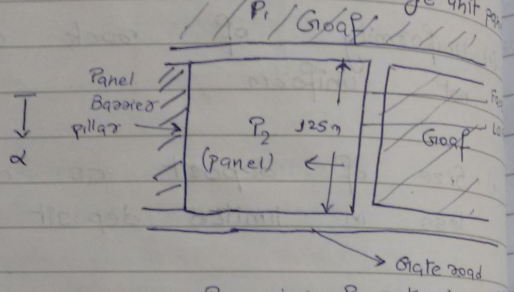
Coal mining → winning → exploitation → extraction

i) Drill + Blast + Load + Transport
ii) Cut + Load + Transport

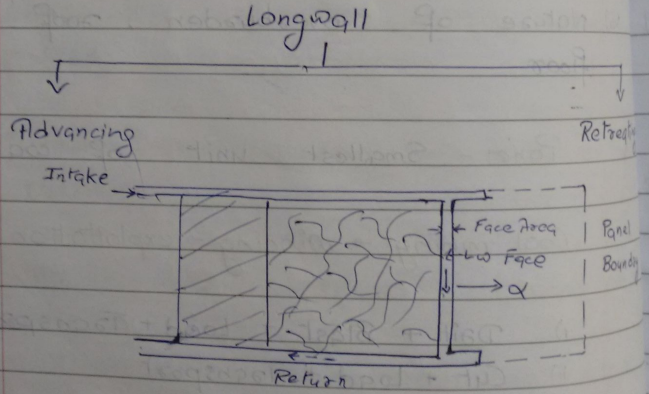
i) LHD, SDL, Manual → R.H, Belts, Rail
ii) Plough, shearer, Coal Cutters etc → Cont. miner, Roadheader

Longwall Mining

75m (double unit LW) 90 m, 100m ... 250m (single unit panel)



Plan view of retreating LWP

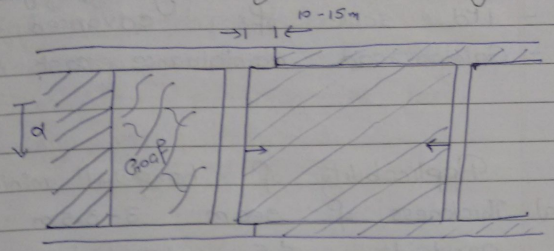


Plan view of advancing LWP

- Drawback of retreating method is the long drivage and ventillation problem (1000 - 3000m) and long gestation period (waiting time for full scale production) and

Drivage of long road cost is high

- Merits of Longwall advancing :-

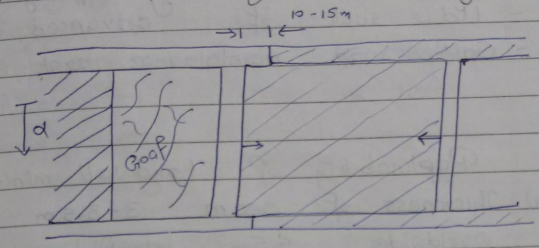


- Short Drivages
- In starting phase full scale production
- Good ventilation is achieved
- Good supervision
- Less development work before the full - scale production
- Drivage cost of development gate road is less
- Easier Supervision, Ventilation
- Easy transport because of proximity of face

- Demerits of Longwall advancing :-
- Gate road maintainance is high throughout life of mine
- Maintainance of goaf is difficult and strata management is costly
- Leakage of air current in

Drivage of long road cost is high

- Merits of Longwall advancing :-



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- Leakage of air current in

Advance - Nature of coal
Exploration seam in advance

goaf (or from goaf) → Ventilation
- Mixing of carbonaceous gases
goaf and poisoning of gases
- Ltd scale of advanced explo
- Gate road maintainance cost is hi

Applicability of Longwall mining
a) Thickness of seam 3-3.5m and worldwide 5.5m (latest), hence think
b) Nature of coal seam should b soft and thrival
c) Uniformity (character) should be of
d) Extention of coalseam - Large dipos as large machines are used
e) Horizontal or mild diposit
f) Presence of gas ; Longwall provi effective ventillation
g) High output requirement

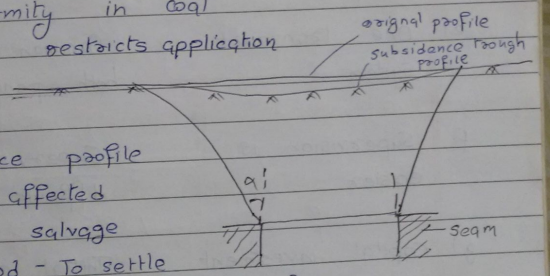
Merits of Longwall mining
a) Very high output and can compete with surface mining
b) Less manpower required as a continuous long face
c) High productivity because of less manpower & more production

OMS → Output per man per shift

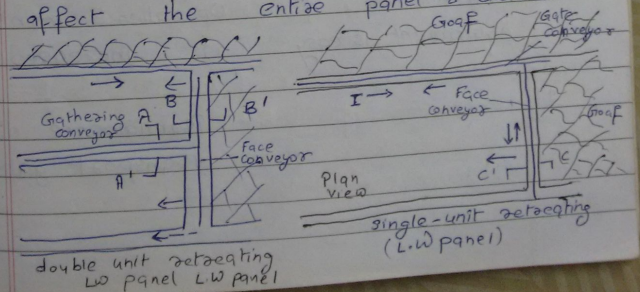
d) Good ventillation
e) Less chance of spontaneous heating
f) In gasy seam is easy to use it
g) Easy transportation
h) Recovery percent is high.
i) Supervision problem is less
j) Safety is ensured

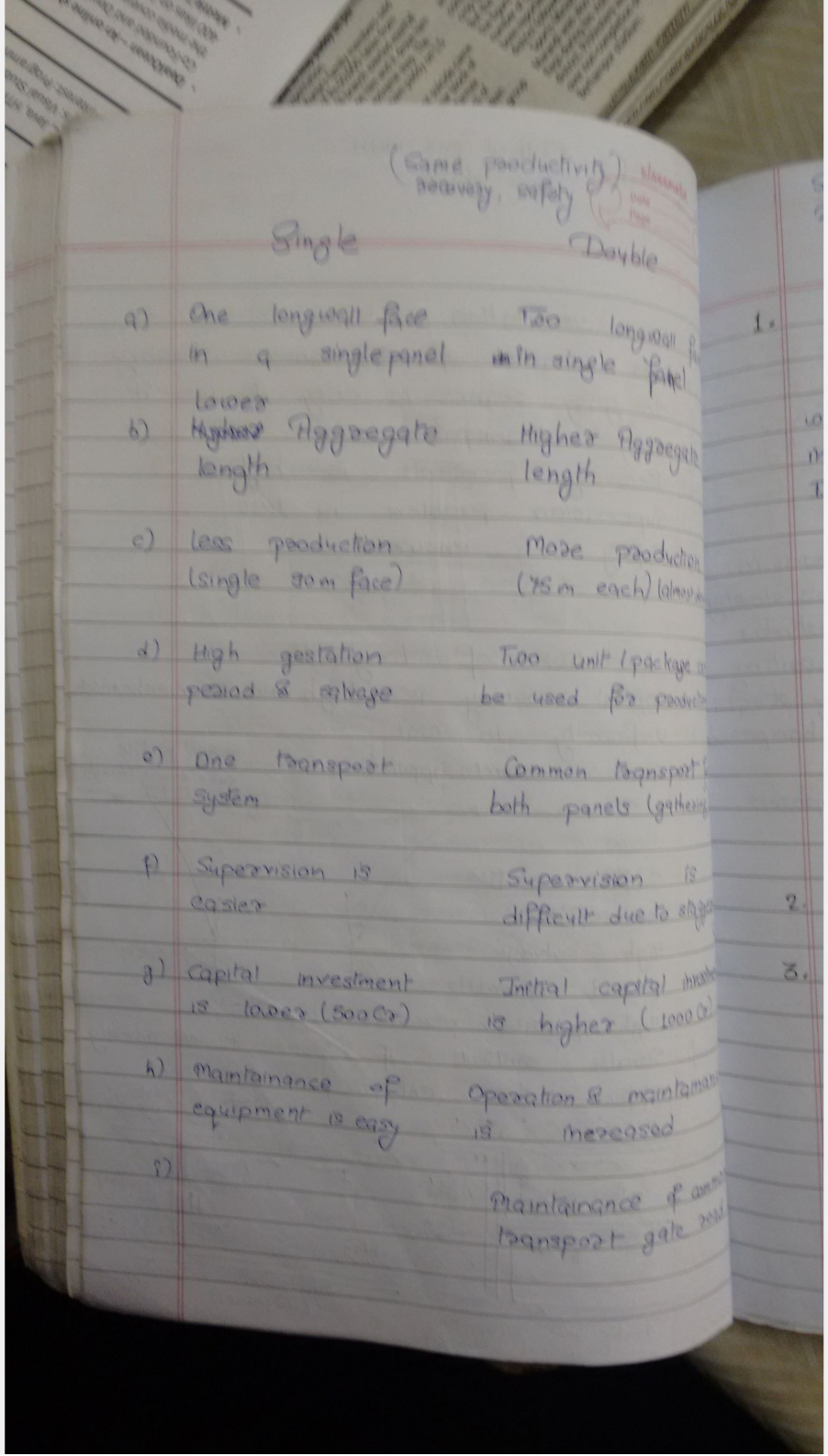
Limitations of Longwall

a) Capital outlay is high due to mechanisation
b) Uniformity in coal seam restricts application

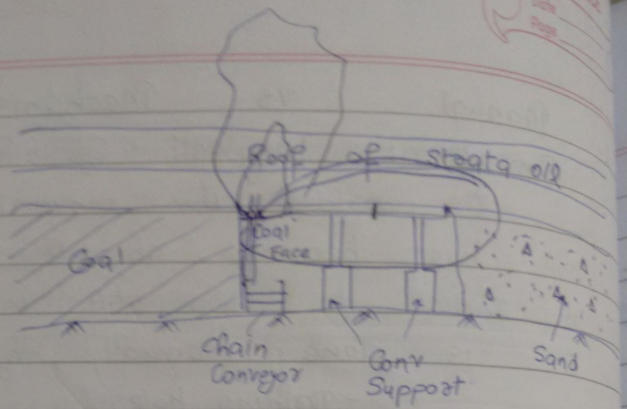


c) Surface profile is affected
d) High salvage period - To settle
e) High gestation period (LWR)
f) Strata control if poor it will adversly affect the entire panel & district




(Same productivity) Recovery, safety

	Single	Double
a)	One longwall face in a single panel	Two longwall faces in single panel
b)	Aggregate length lower	Higher Aggregate length
c)	Less production (single 300m face)	More production (75m each)
d)	High gestation period & salvage	Two unit / package can be used for production
e)	One transport system	Common transport both panels (gathering
f)	Supervision is easier	Supervision is difficult due to
g)	Capital investment is lower (500Cr)	Initial capital investment is higher (1000 Cr)
h)	Maintainance of equipment is easy	Operation & maintenance is increased
i)		Maintainance of common transport gate road



Caving is common in whole world but in India sto... is done as caving (i) disturbed buildup area and (ii) for waiting for breakage of overlying str... face work may be hamp...

90m² area can be exposed according to legislation

Goaf Filling / Stowing

i) Hydraulic Filling
ii) Pneumatic Filling
iii) Mechanical Filling

1. Strong, non laveable roof
2. Extent of built up area railway lines, buildings etc.

and reason why sand is used →

i) Readily Available
ii) Readily Transportable
iii) High packing density
iv) High permeability
v) Excellent Drainage
vi) High bearing strength.
vii) High stiffness.

but

Sand is depleting resource as it is also used in construction / civil industry for various usage

24/08/2014

Hydraulic Gradient / Profile → H/L ratio

- Less than 1 in 7 is not admissible for stowing
- Let H : height of vert. distance b/w the outlet of mixing chamber & the entry pt in the goaf = 100m
- L = horizontal length of stowing range = 1000m

H/L ratio = 100/1000 = 1/10 not admissible for proper

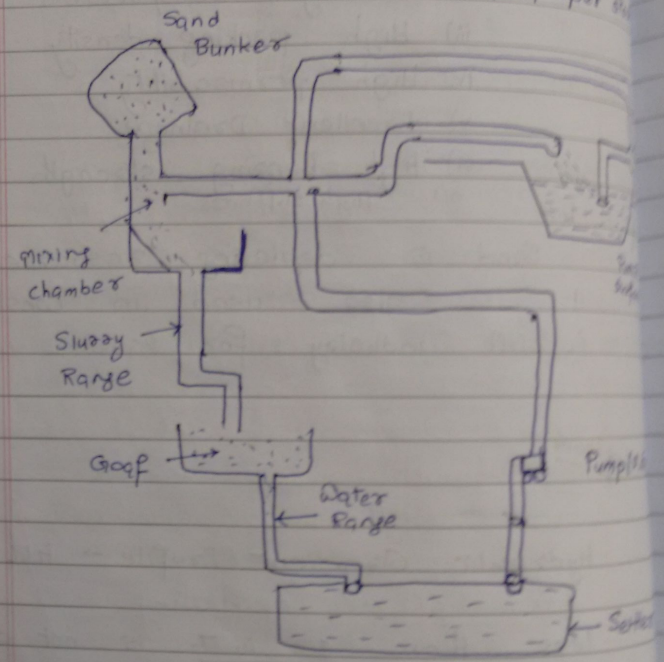


Fig: A representative scheme of hydraulic stowing

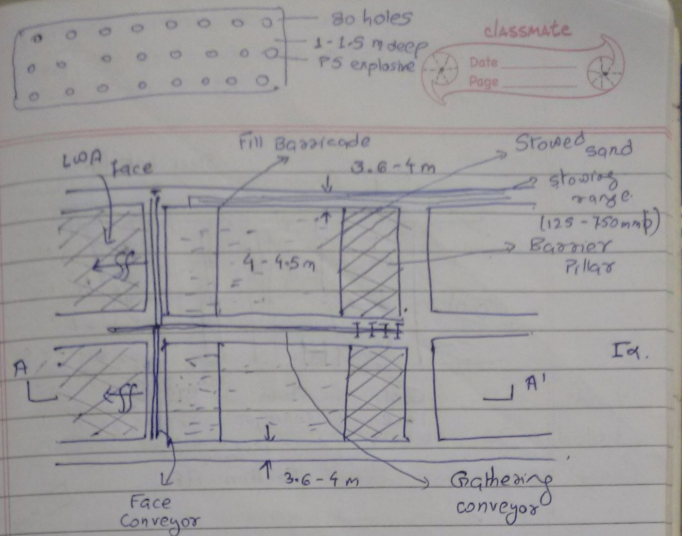
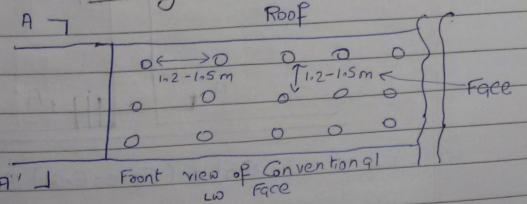


Fig: Plan of double unit LWA panel with hydraulic stowing.

- Operation on conventional longwall face

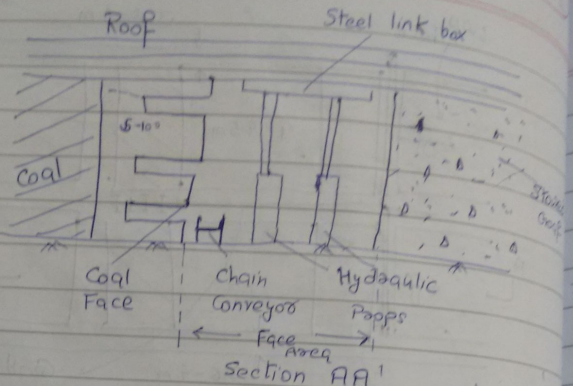
1. Drilling
2. Charging
3. Blasting
4. Support
5. Load
6. Transport Outby

Drilling



Front view of Conventional LW Face

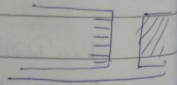
- From face drilling



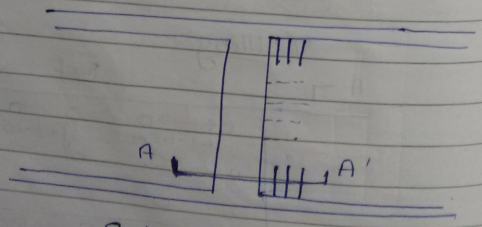
Section AA'

The angle 5 - 10° is given to the hole to concen the energy to loosen adhesio ie b/w roof and coal and to create fractures for stowing but roof should be strong.

- Form stable D&B



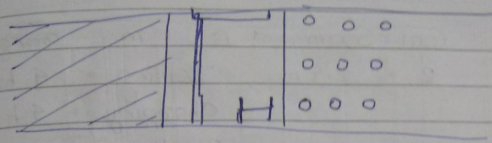
Q. Show drilling pattern across the fac



Stable (Face-End) By Hock Drilling & Blasting

7/10/14

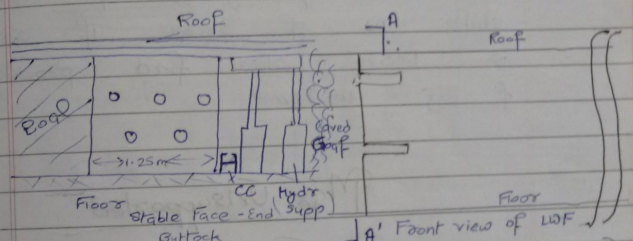
larger anthracite lumps have higher market value.



7/10/14

- 100m long face - upto 2m thick coal seam ≈ 2 rows of holes (each row ~ 80 holes)

- 2.3 m thick coal seam ≈ 3 row of holes (each row ~ 80 holes)



Section AA' of LWF and Blasting.

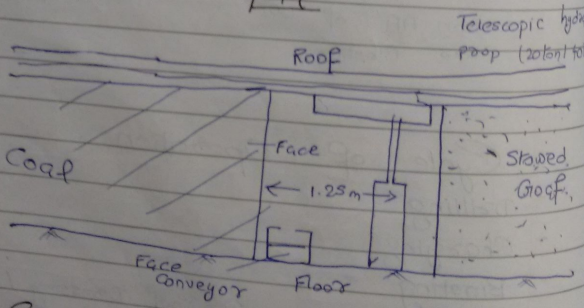
Cycle of Operation

- Drilling
- Charging
- Blasting
- Water Spraying & Roof Dressing / Face
- Tightening of Support
- Loading
- Shifting of chain conveyor

Q. Coal Seam is in range of 2 - 2.4 m, Drilling = 4 hrs
Charging = 4 hrs
Blasting & Fume = 1 hr
Water Spraying = 2 hrs
Tightening = 2 hrs
Support Erection = 6 hrs
Loading of coal = 6 hrs
Chain Conveyor Shift = 6 hrs

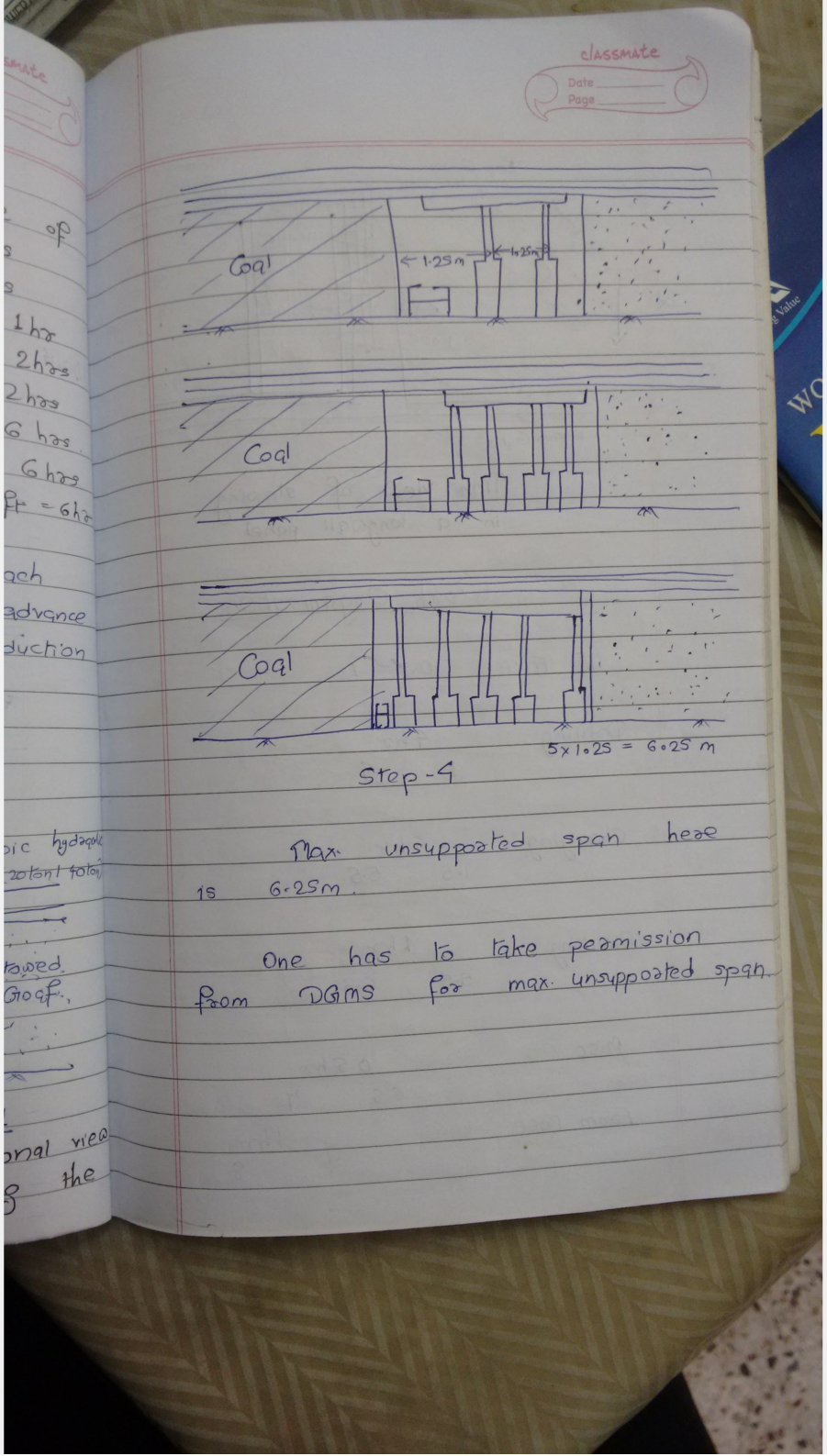
Find no. of cycles if each shift is of 8 hrs if advance is 1.25 m also find production if $\rho = 1.5\ T/m^3$

Max Unsupported Span



Step-1

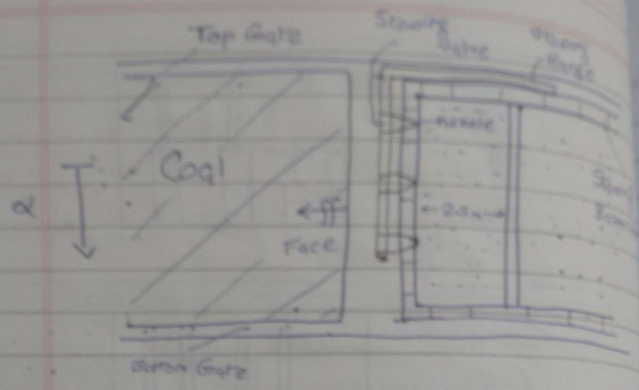
Stepwise illustration of sectional view of longwall face explaining the max unsupported span.



Step-4

Max. unsupported span here is 6.25m.

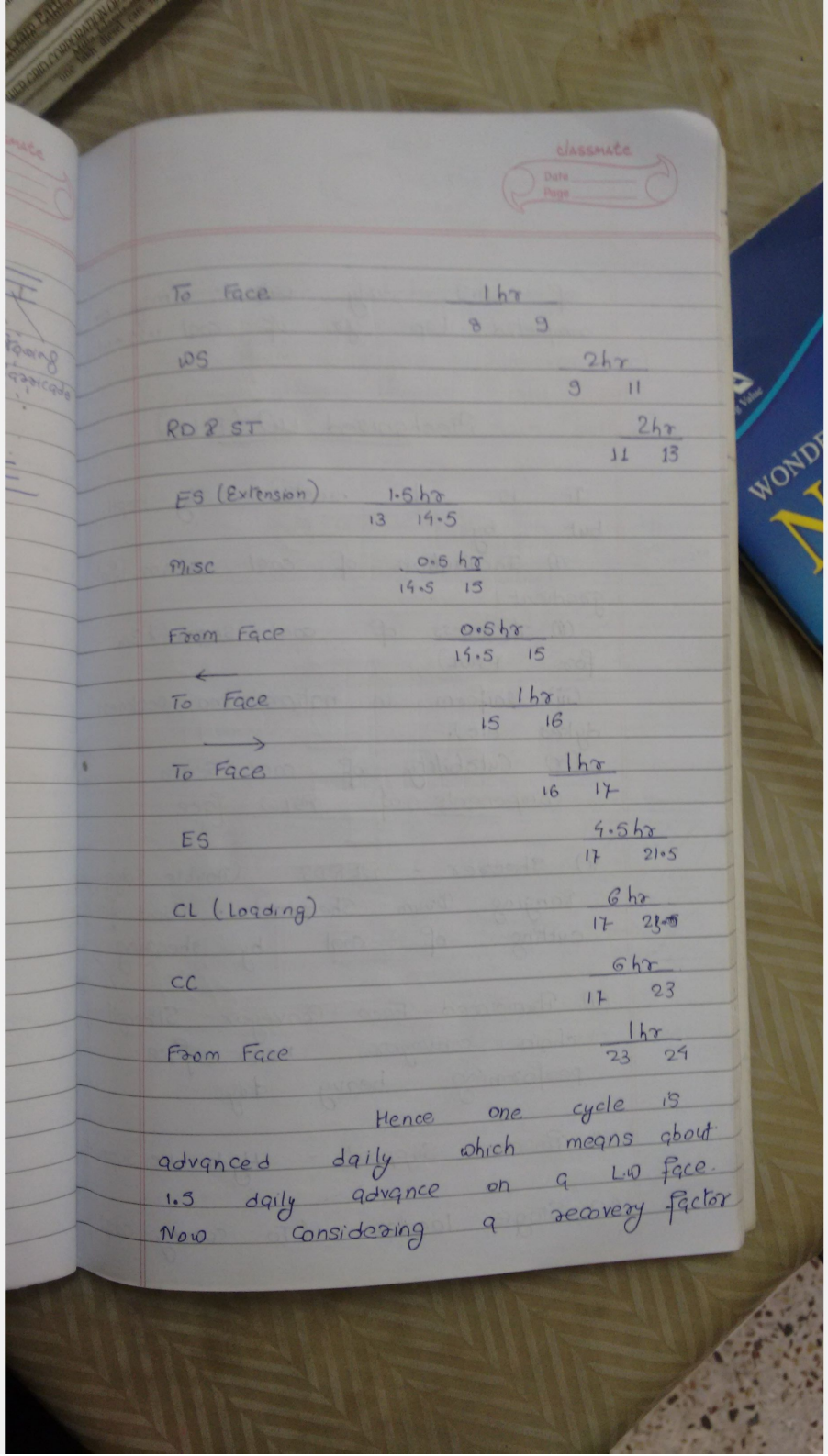
One has to take permission from DGMS for max. unsupported span.



Plan view of stooing in a longwall panel

Work Organisation

To Face	0	1
Drilling	4 hr	
	1	5
Charging	4 hr	
	1.5	5.5
Blasting	1 hr	
	5.5	6.5
Misc	0.5 hr	
	6.5	7
From Face	1 hr	
	7	8



To Face 1hr (8 9)

WS 2hr (9 11)

RD & ST 2hr (11 13)

ES (Extension) 1.5hr (13 14.5)

Misc 0.5 hr (14.5 15)

From Face 0.5hr (14.5 15)

← To Face 1hr (15 16)

→ To Face 1hr (16 17)

ES 4.5hr (17 21.5)

CL (Loading) 6 hr (17 23)

CC 6hr (17 23)

From Face 1hr (23 24)

Hence one cycle is advanced daily which means about 1.5 daily advance on a L.W face. Now considering a recovery factor

of 0.9 daily output may be completed Lsp gr. of coal 1.25 - 1.5

(v)

Mechanised LW (PSLW)

It is not restricted by depth but by

(i) Inclination of coal seam (flat gradient)

(ii) Thickness of coal seam (1.3m for PSWL)

(iii) Uniform in nature (no weakness dykes etc).

(iv) Cutability of coal seam

Components of PSLW face :-

(i) Shearer - DERDS (Double Edge Ranging Drum Shearer). Used for cutting of coal by shearing

(ii) Armoured Face Conveyor - Strengthen chain conveyor near face performing heavy duty

(iii) Powered Supports - Hydraulic Support

(iv) Stage loader - (To convey coal

of 0.9 daily output may b
completed Lsp gr. of coal 1.25 - 1.

(v)

Mechanised LW (PSLW)

It is not restricted by depth but by

(i) Inclination of coal seam (flat gradient)

(ii) Thickness of coal seam (>3m for PSWL)

(iii) Uniform in nature (no weakness dykes etc).

(iv) Cutability of coal seam

Components of PSLW face :-

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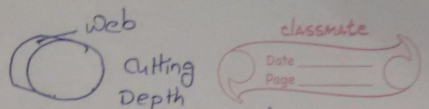
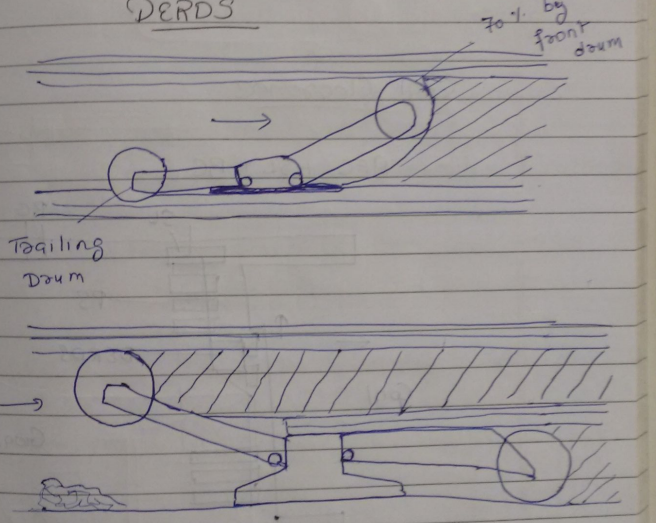


from AFC to belt conveyor)

(v) Gate Belt Conveyor - Recieves coal from stage loader and will discharge coal to main belt conveyor

DERDS



2nd or Tail drum does the brooming job.

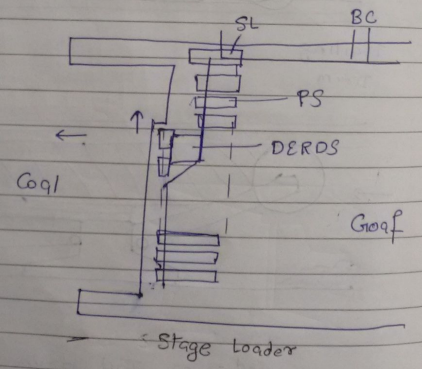
Shearer

Web is 0.6 - 1m
Cutting 0 - 5 m / min
Flitting 0 - 10 m / min.

Flitting is moving without cutting
Machine is mounted on AFC

Coal Clearance

AFC + SL + BC



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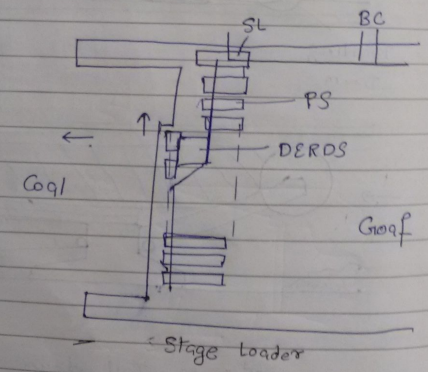


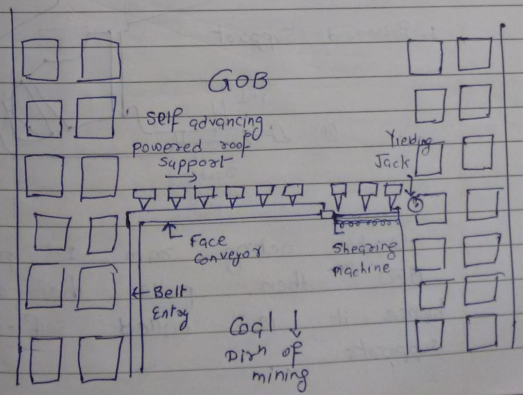
Uni or Bi Directional Cutting

MG → TG Cut
MG ← TG No Cutting
} Unidirectional Cutting

MG → TG Cut
MG ← TG Cut
} Bidirectional Cutting

- Under Indian Conditions,
  We have unidirectional cutting
  - Efficient Cutting
  - Efficient Recovery & Less Coal losses
  - Dust Minimisation.

- Coal → Shearing loading unit



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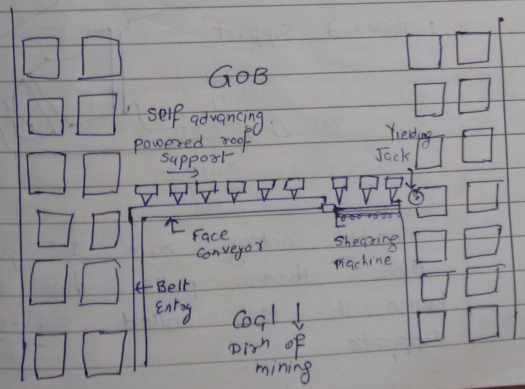
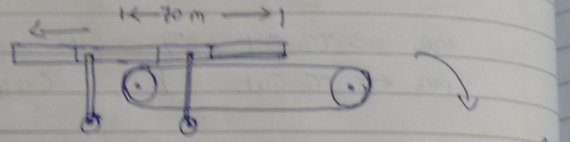
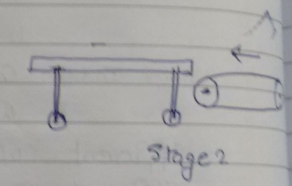


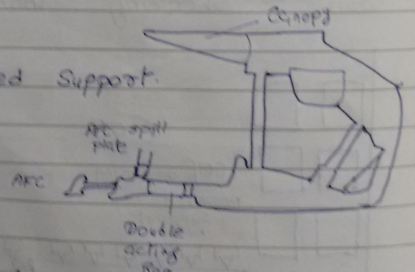
Side loader is mobile and overlap b/w side loader and chain conveyor is 70 - 80 m and keeps on moving backw



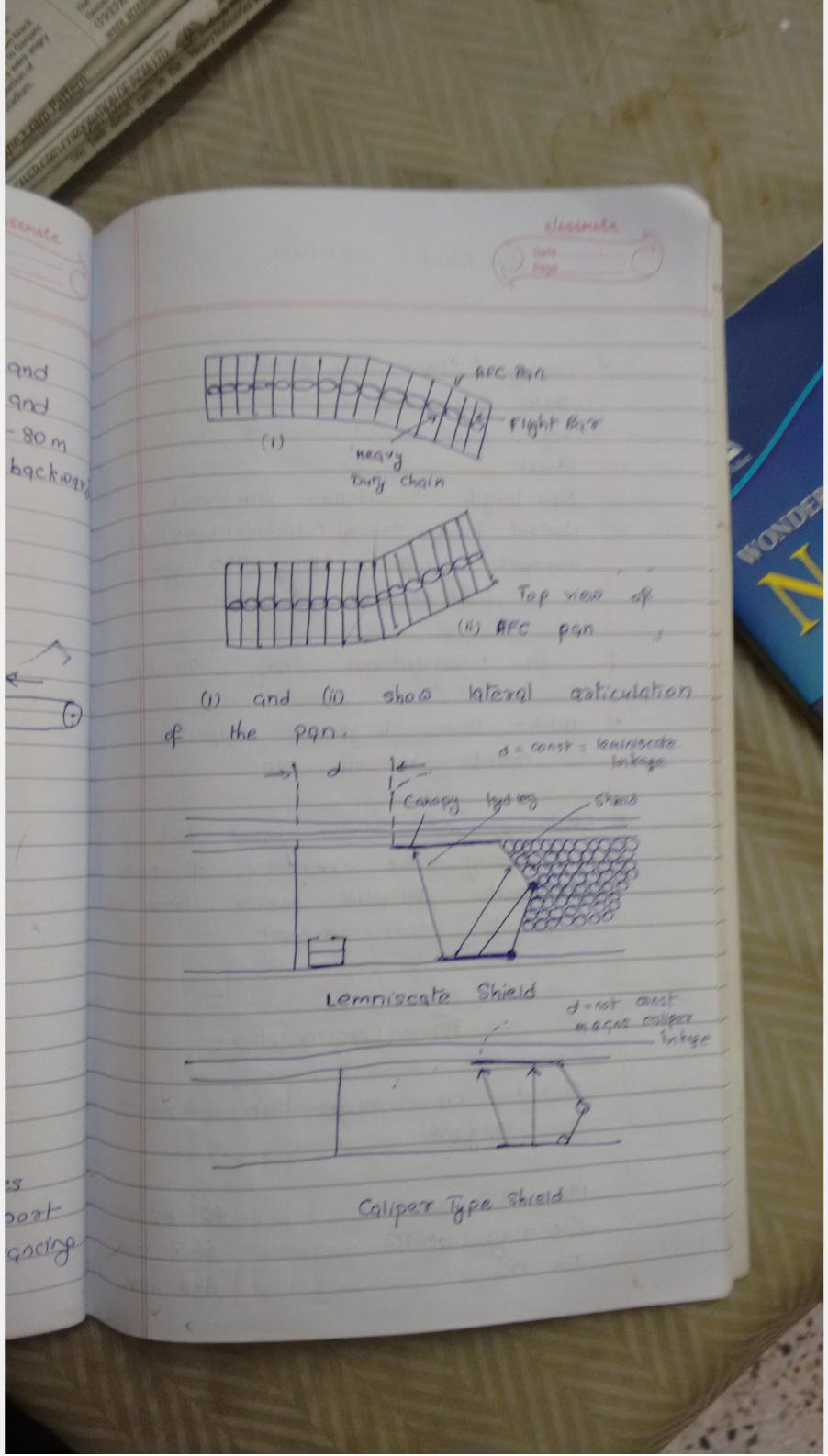


Support Type

1. Powered Support



Double acting ram 1st pushes AFC then pulls the support hence it is called self-advancing supports



Ave speed : 2.5 m/min

- Canopy (4700 x 1250 x 518 mm)
- Base
- Legs
- Shield
- Ram length Coordination with face
- Control Unit manual / adjacent / batch / electro
- Support specification (02 leg · 320 aggregate (2 * 320 or 4 * 620)

In conventional only 20 ton

- Batch :- From 1 power support, can control no of unit
- Electrohydraulic :- Sensor based tech for controlling the movement of power support . Individual person need not go to power support

Face Organisation

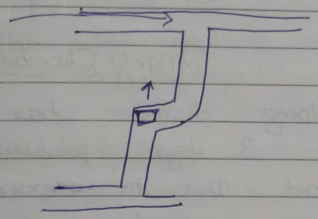
Based on unidirection (maingate to tailgate)

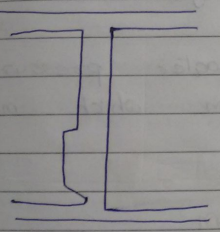
MG TG	
Cleaning at TG	45 - 60 min
TG MG	6 - 8 min
	6 - 8 min

Sumping (MG)	5 - 7 min
Coal Cleaning (MG)	4 - 7 min
Drum Positioning (MG)	5 - 8 min
Support Advance (Sumped Area)	20 - 35 min
Miscelaneous	5 - 15 min
	100 - 160 min

Mean Cycle Time 130 min.

Coal gets spilled in Tail Gate.





Sumping is to move into the face ~~cutted~~ in the begining

Some coal has to be cleaned when shearing moves into face.

Ranging of drum is positioning of drum.

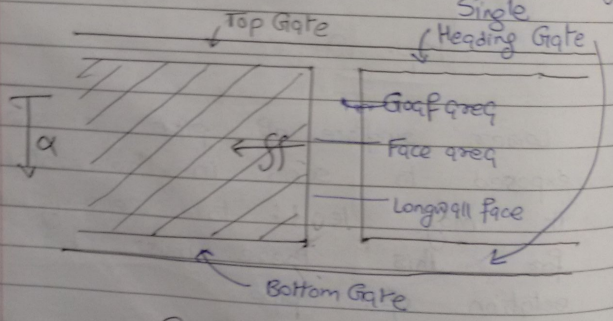
Time from end to face = 2hr

The right quantity of ... and sand such that there ... no jamming in the horizontal range of stowing.

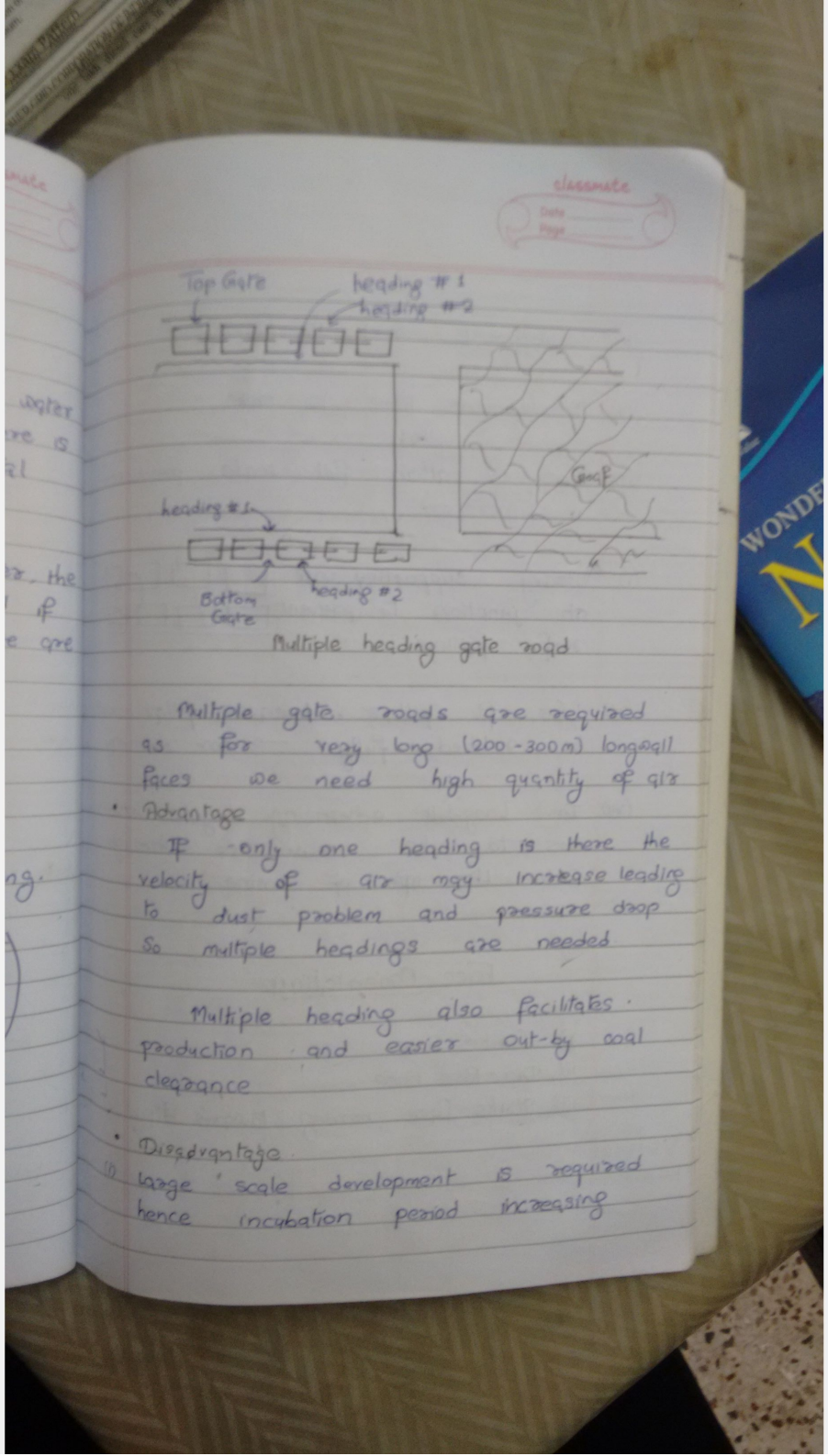
If there is more water ... rate of stowing is poor and if there is more sand there ... chances of pipe jams.

Heading

Moving front is called heading.



Single heading gate road



Multiple heading gate road

Multiple gate roads are required as for very long (200-300m) longwall faces we need high quantity of air

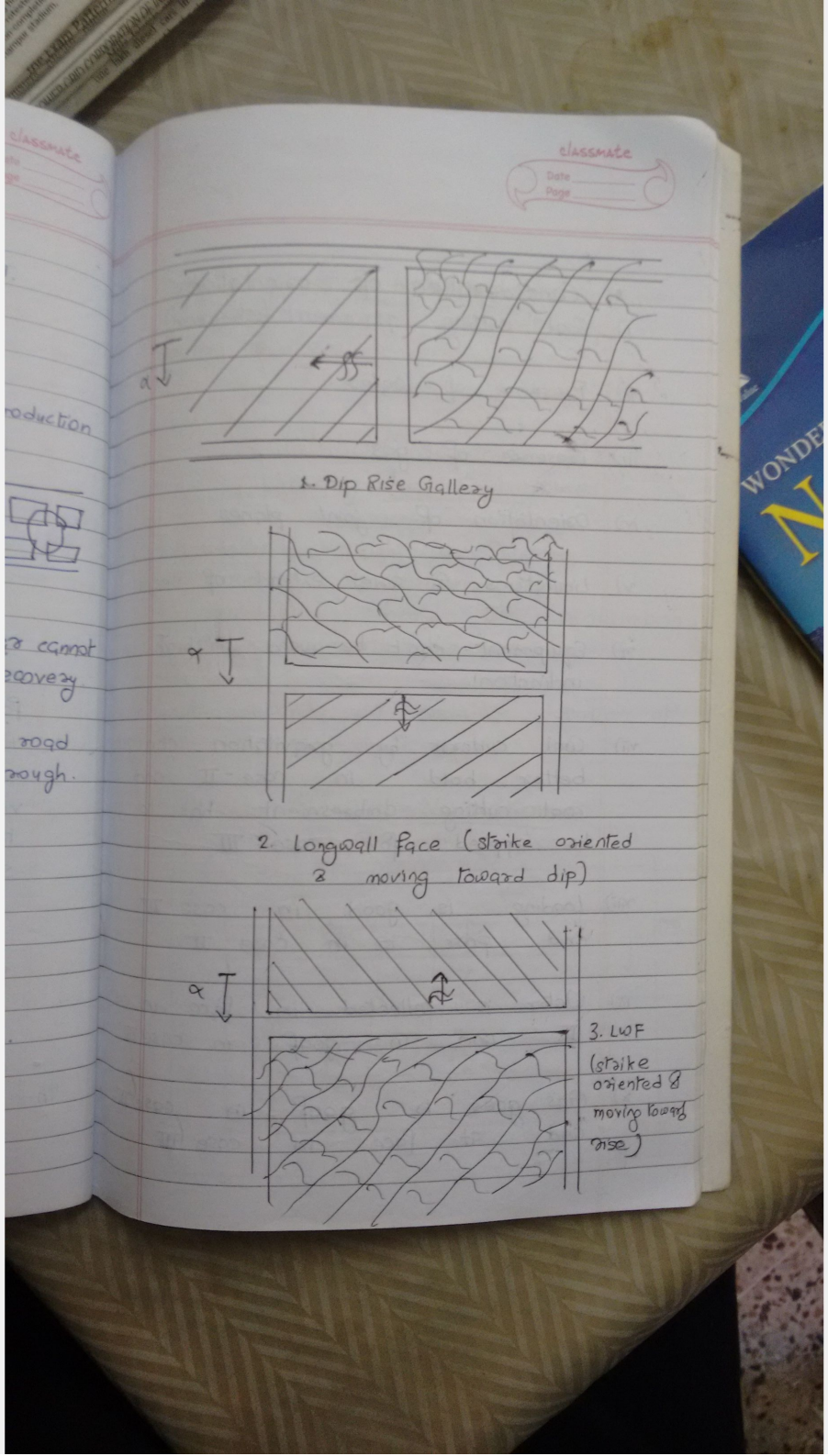
- Advantage

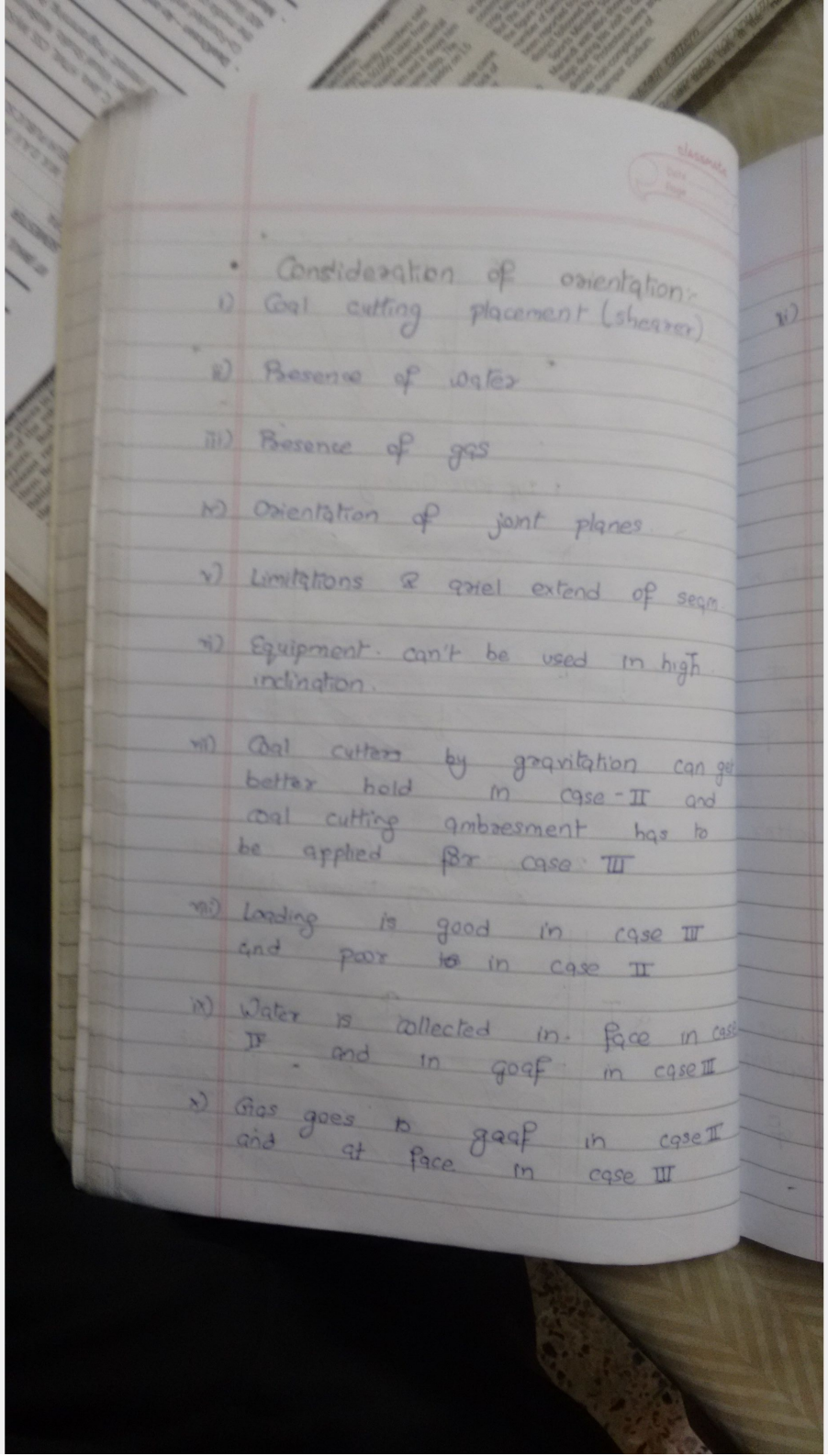
If only one heading is there the velocity of air may increase leading to dust problem and pressure drop so multiple headings are needed

Multiple heading also facilitates production and easier out-by coal clearance

- Disadvantage

(1) large scale development is required hence incubation period increasing





• Consideration of orientation:-

i) Coal cutting placement (shearer)

ii) Presence of water

iii) Presence of gas

iv) Orientation of joint planes

v) Limitations & axial extend of seam

vi) Equipment can't be used in high inclination.

vii) Coal cutters by gravitation can get better hold in case - II and coal cutting ambasement has to be applied for case III

viii) Loading is good in case III and poor is in case II

ix) Water is collected in face in case II and in goaf in case III

x) Gas goes to goaf in case II and at face in case III

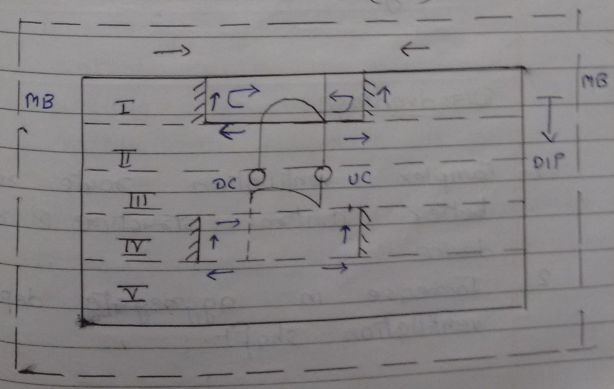
iv) For dip of high degree we have to work along apparent dip or along strike.

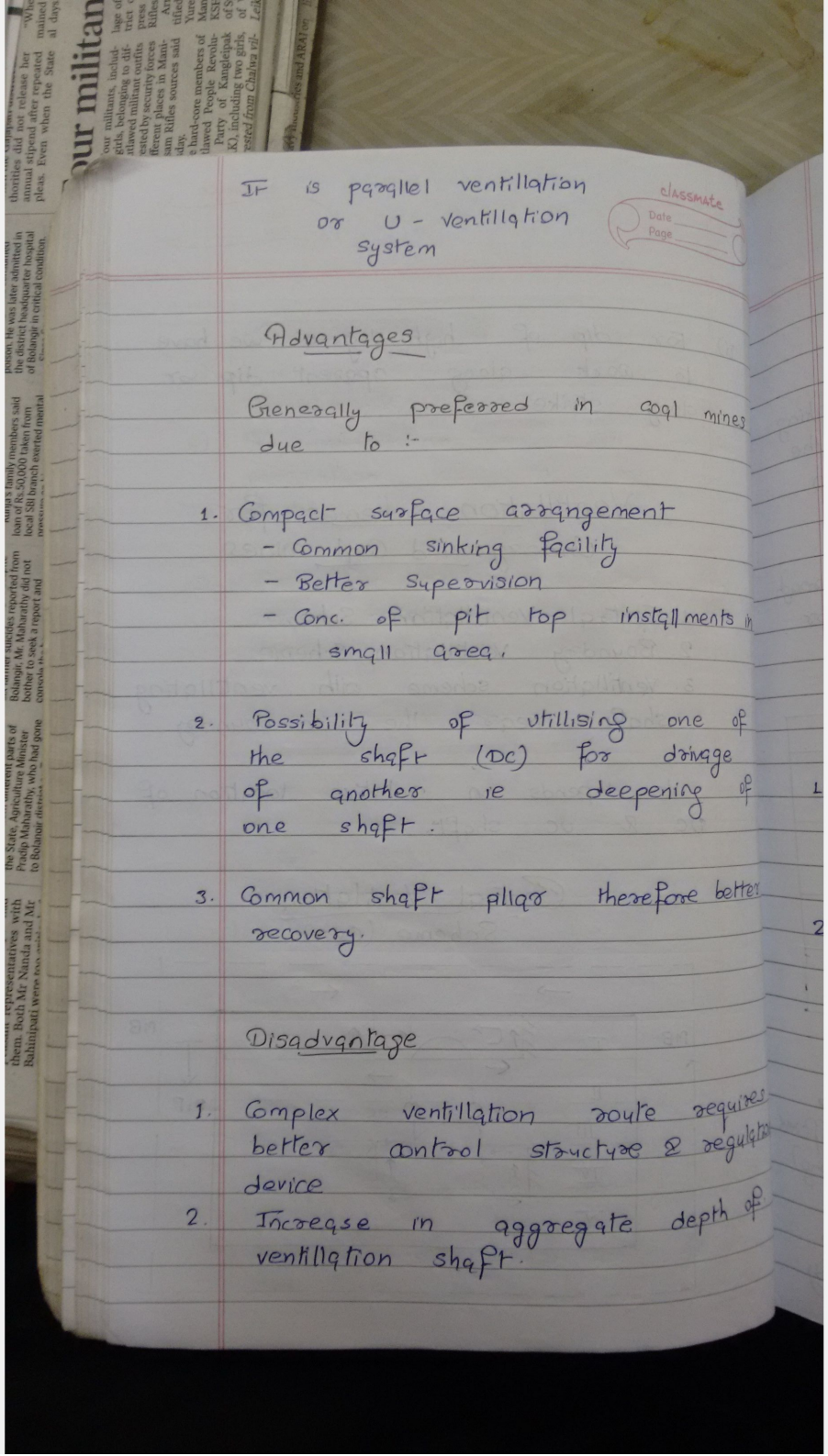
Ventillation schemes for Underground Coal mines

1. Central Ventillation Scheme
2. Boundry Ventillation Scheme
3. Ventillation scheme with ventillating shaft near the rise boundry.

it depends on relative location of DC & UC shaft.

Central Ventilation Scheme (CVS)





IF is parallel ventillation or U - ventillation system

Advantages

Generally preferred in coal mines due to :-

1. Compact surface arrangement
   - Common sinking facility
   - Better supervision
   - Conc. of pit top installments in small area.

2. Possibility of utilising one of the shaft (DC) for drivage of another ie deepening of one shaft.

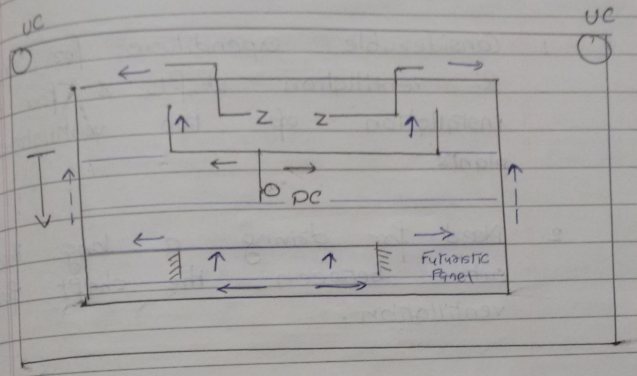
3. Common shaft pillar therefore better recovery.

Disadvantage

1. Complex ventillation route requires better control structure & regulation device
2. Increase in aggregate depth of ventillation shaft.

If is independent or
z ventillation system

Boundry Ventillation System



1. Uniform operation of mine fan (constant fan power requirement, constant air route lengths).

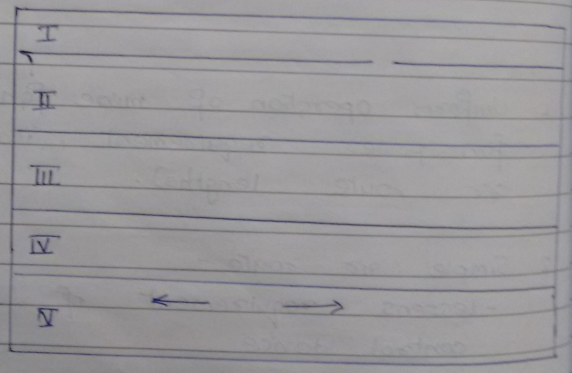
2. Simple air route -
   - Lessens requirement of ventillation control device
   - Leakage is less
   - Ventillation efficiency is better

3. Ventillation fan needs to develop less pressure due to less pressure loss.

Disadvantage

1. Considerable expenditure for sinking 2 ventillation shafts & for the installation of two ventillation plants.

2. Need for driving a long through cut between the shaft for ventillation.



- These are serious limitations hence CVS in generally preffer for coal seam lgently dipping.

- However BVS may be applicable due to presence of already

existing worked out areas (toward the rise of mine field), whose ventillation opening could be used for the BVS

- By disposing one of the shafts at centre of rise boundry the only advantage is:

Reduction in no. of ventillation (vc) shafts & smaller depth of the ventillation shaft in comparision to CVS.

But for all this merits of CVS are sacrifised

Hence, BVC is not frequently used / recommended.

U → parallel ventilation system in panel

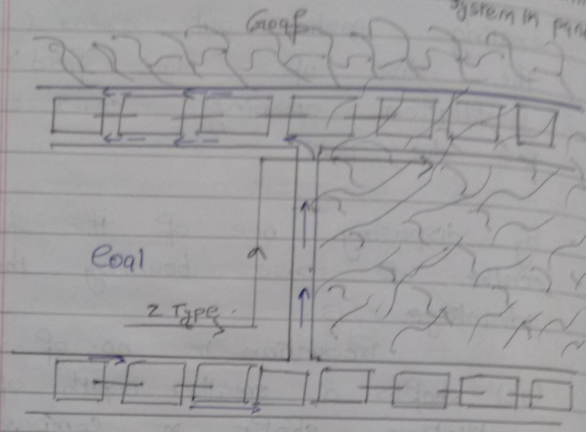
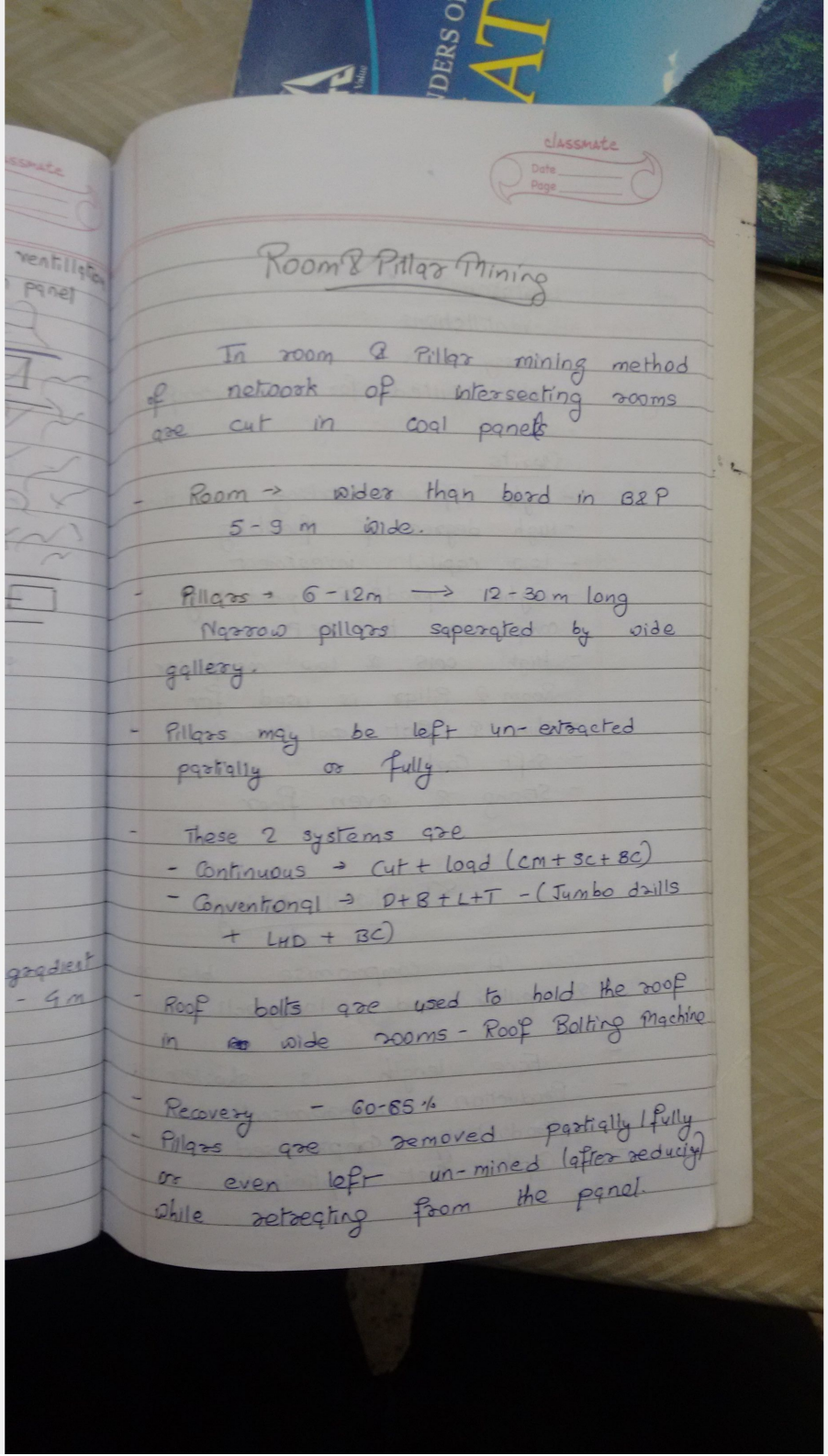


Illustration of U-Type of panel ventilation in CVS

Continuous Miner

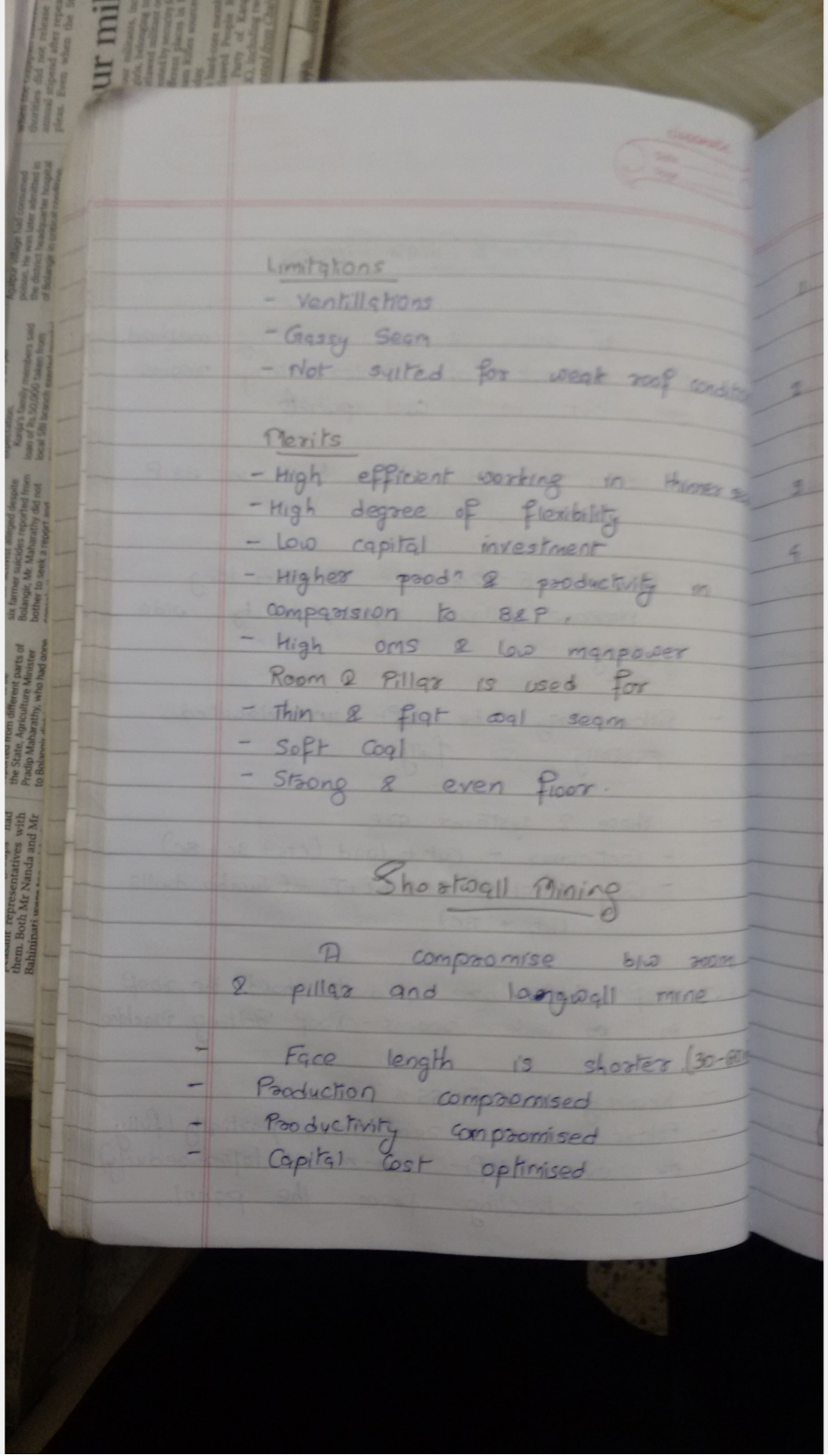
Rate of drivage - 50 m / day
Production - 1500 t / day
for seam of 1 in 5 gradient or flatter. thickness 3m - 9m



Room & Pillar Mining

In room & Pillar mining method of network of intersecting rooms are cut in coal panels

- Room → wider than bord in B&P 5 - 9 m wide.
- Pillars → 6 - 12m ⟶ 12 - 30 m long Narrow pillars seperated by wide gallery.
- Pillars may be left un-extracted partially or fully
- These 2 systems are
  - Continuous → Cut + load (CM + SC + BC)
  - Conventional → D+B+L+T - (Jumbo drills + LHD + BC)
- Roof bolts are used to hold the roof in wide rooms - Roof Bolting Machine
- Recovery - 60-85%
- Pillars are removed partially / fully or even left un-mined (after reducing) while retreating from the panel.



Limitations
- Ventillations
- Gassy Seam
- Not suited for weak roof condition

Merits
- High efficient working in thinner seam
- High degree of flexibility
- Low capital investment
- Higher prodn & productivity in comparision to B&P.
- High OMS & low manpower

Room & Pillar is used for
- Thin & flat coal seam
- Soft Coal
- Strong & even floor.

Shortwall Mining

A compromise b/w room & pillar and longwall mine

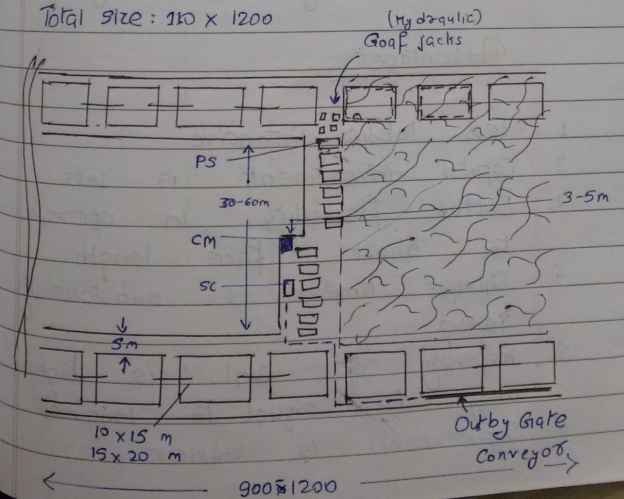
- Face length is shorter (30-60
- Production compromised
- Productivity compromised
- Capital cost optimised

Equipments

1. Shearer and AFC are replaced by Continuous Miner and Shuttle car
2. Winning is done by only cutting and loading not blasting.
3. Specially designed powered support.
4. Gate Belt Conveyor at main gate

Method	Technology
Longwall	Manual
Shortwall	Continuous.
R & P	

Total size : 110 x 1200



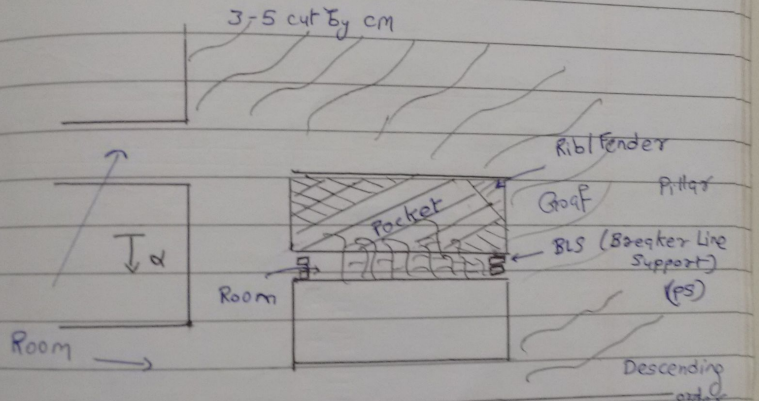
1.1 - 3.1 m)

in coal seam
longwall

is less
in operation due
length
substansially

is higher and
long wall

30 - 40 % than R & Pillar

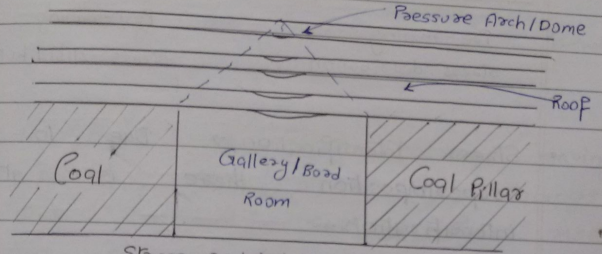


Pocket & Fender method of pillar extraction in R & P (with BIS)
(Plan view)

UME - II

PR

- Stress Concentration - In underground mining the stress redistribution and stress superimposition there is stress concentration



Stress redistribution & concentration concept vis-a-vis pressure arch/ dome formation

Q. Illustrate the stress distribution and concentration in wide opening by taking an example of longwall face.

- Abudment → Joining pillars / adjoining pillar.

When opening is made, the amount of rock in stress - relaxation zone just above the exhausted coal is under constant gravitational pull, and it is liable to collapse. The coal rocks tends to sag and this is defined by the stress - relaxation zone.