OPENCAST MINE PLANNING, DEPLOYMENT OF HEMM FOR OPTIMUM UTILISATION, TOTAL TECHNICAL PARAMETERS OF HEMM INCLUDING LIMITATIONS, & HAUL ROAD & ITS MAINTENANCE.

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OPEN CAST MINE PLANNING

Factors that influence planning:

1) Demand of coal.
   a. Countrywide demand
   b. Regional demand
2) Distribution of coal deposits
3) Quality of coal
4) Pricing policy for coal
5) Available infrastructures: rail, road, power, etc.
6) Nature of deposits (influences site, area method of work, & equipments of mining)
7) Availability of equipment
8) Existing work culture

Surface mining

Advantages

1) Higher % recovery of coal.
2) No problems of roof control, ventilation, etc, & less hazards & dangers
3) Early extraction & Quick return of capital
4) Large output possible
5) High OMS possible
6) Artificial lights needed only after dusk hours.
7) High degree of mechanization possible.

Disadvantages:

Uneconomic at greater depths

1) Environmental problems
2) Weather affects the work.

Conditions suitable for surface mining

1) Gentle gradient: less cost, large area, back OB dump possible in de-coaled areas,
2) Thick seams
3) Shallow initial depth of the coal deposits (Stripping ratio 0.6 to 6): less gestation period.
4) Surface is free from structures that are costly to shift
5) Quality of coal
Factors affecting planning & designing of a surface mine

1) Geological factors
   a. Dip
   b. Size of the deposits
   c. Form of the deposits
   d. Depth of the deposits from surface
   e. Surface topography
   f. Geotechnical parameters of the rock

2) Availability of funds/capital

3) Break even Stripping ratio/cost economic analysis

4) Production targets

5) Degree of mechanization

6) Environmental conditions & the township, land reclamation, etc

7) Availability of water, power, skilled labour, transport facilities,

Steps in Opencast mining

1) Determination of mine boundaries: Exclusion of: high SR area (deep seated, hill, thinning/splitting of seam, stone parting, geologically disturbed areas (faults), low quality areas, etc. natural boundaries (river/nallah, faults), township, railway line, operational factors like optimum strike length for transportation.

2) Selection of mining equipment (type & size): depends on targeted output, life of the mine, dip, strike lengths, thickness of seam, SR, geological disturbances, topography,

3) Methods of opening
   a. Access trench
   b. Box cut

4) Sump development

5) Coal & overburden benches

TYPE OF PLANS:

1) LONG TERM PLANS (MASTER PLANS & PLANS FOR THE LIFE OF THE MINE GR, FR, PR etc.): these plans need revision at regular intervals due to dynamic changing environment. These plans are guidelines.
   a. Network of power lines, roads, railway lines, water supply lines
   b. Individual mine facilities like, CHPs, townships, railway sidings, approach roads,
   c. Central mine facilities like, CWS, Central stores, Central substations, Central townships, Central magazine, SMS plants, etc.
   d. Likely investment
   e. Likely requirement of major equipments

2) MID TERM PLANS (FOR 5 TO 10 YRS)

3) SHORT TERM PLANS (Annual Operation Plans, Monthly Plans, ETC.)

Objectives of operation plans:

1) To achieve the targeted output
2) To maximize the equipment productivity
3) To optimise the working parameters for shovels & draglines
4) To schedule the deployment of equipments
5) To direct the operational staff
6) To monitor the working
**Data inputs required for preparation of operation plans for deployment of equipments.**

1) Working plan of the mine.
2) List of existing HEMM
3) List of HEMM to be procured / erected / commissioned and its schedule
4) List of HEMM to be surveyed off
5) Tentative schedule of maintenance for draglines and shovels

**Issues involved in the operational plan preparations.**

1) Mine Capacity assessment
   a. Shovel dumper capacity assessment
      i. Digging capacity assessment
      ii. Hauling capacity assessment
   b. Dragline capacity assessment & optimization of working parameters for the targeted output of coal
      i. Dragline re-handling assessment
      ii. Dragline solid OB handling assessment
2) Matching the mine capacity with the targeted output of coal production & OB removal
3) Scheduling of the equipment deployment
4) Planning for accommodation of OB in dumps
5) Monsoon plan
6) Planning of Haul roads, approach roads & ramps
7) Drilling plans

**DRAGLINE OPERATION PLANNING**

Opencast mines using draglines for over burden removal involve the excavation of a series of parallel strips and each strip or cut is worked in a series of blocks. Normally digging a wedge shaped key cut with the dragline standing in line with the new high wall starts excavation of each block having dimensions as per the balancing diagram, which is prepared after extensive iterative calculations. After a key cut is complete the dragline moves closer to the old high wall from where it excavates the remainder of the block.

The total capacity of dragline is fixed, it comprises of solid and re-handling, as the dragline has also to re-handle certain amount of over Burden in most of the cases. The percentage of total capacity of draglines to be used for re-handling depends upon many factors.

1. Method of working.
2. Variables in dragline working.
   A. Machine variables.
   B. Geo mining conditions.
   C. Operational variables.

To maximize the gainful utilization of dragline these re-handling percentage has to be kept minimum in a given situation.

To minimize the re-handling percentage the drawing of balancing diagram is necessary. Balancing diagram is nothing but graphical representation of the cross section of the directory working. As the name suggests, the over Burden to be removed by the dragline shall be balanced in the available void, of previous cut, such that the re-
handling percentage is minimum, the internal dump is safe and stable, and least susceptible to failure.

**DRAGLINE BALANCING DIAGRAM:**

Dragline balancing primarily means establishing relationship between the system capacity & its workload. High capital outlay for dragline requires efficient operation to obtain low cost of OB removal. Since deployment and operation of a dragline in different modes affect its productivity, it will be necessary to study the effects on production and productivity of different operational schemes. A dragline-balancing diagram is prepared incorporating suitably selected machine, design and geo-technical parameters of quarry. The process of preparing such a diagram is highly interactive and time consuming. If a dragline is deployed as per the guideline-balancing diagram, better safety, higher productivity and greater production can be achieved.

The dragline can be deployed in any cut only after optimizing the cut parameters with the help of balancing diagram. If this procedure is not followed, then we are bound to meet with problems regarding proper deployment and utilization of dragline, which may result in heavy production losses. This in any case is not advisable. The following points must be considered while preparing balancing diagrams:

1. The cut shall be divided in different sections as per the uniformity of the cut width, available dumping space (void) of previous cut and cut dumping, availability of void near central entry and mid entry. It is better to prepare different balancing diagrams for these sections. This will give the realistic picture for the actual deployment of the dragline.
2. The possibility of preparation/availability of formation/face, approach roads/ramps at proper time as per the requirement of balancing diagram shall also be checked, taking in to consideration the actual geometry of the shovel benches.
3. Special attention shall be given for mid entry, central entry for extra overburden accommodation and safe dumping geometry.
4. The cut dumping, silt deposition, band dumping, dump- Bell, etc shall be taken in to account for availability of void space in previous cut.
5. The possibility of simple side casting shall be tested, if sufficient void is available. This will avoid the necessity of extended bench method and will result in reducing the re-handling percentage.
6. The quantity of cut dumping shall be judiciously worked out. The detailed study is needed for proper analysis of optimizing the permissible quantity of cut dumping.
7. The detailed study is needed for gainful use of blast casting, determining profile of muck and volume of overburden casting by blasting, which many reduce the workload of dragline and also the effect on working level of dragline. If proper designed blasting reduces the bench height, the re-handling percentage can considerably reduced. The blast profile shall be such that the level of total bench uniformly reduced, and heaving or uneven muck profile is minimum.
8. The necessity of key cut shall be properly analyzed.
9. The advance of both the dragline is balanced as per the requirement and the distance between the two draglines is constantly maintained. This can be achieved by proper distribution of workload (volume of overburden, solid and re-handling) between both the dragline.
10. If the operating level of dragline exposing coal is reduced then the percentage of re-handling will be considerably reduced.
11. The power layout and cable layout for both the dragline shall be given due consideration when designing balancing diagram.
12. The approach road for dragline working on lower bench for exposing coal shall be maintained for operation and maintenance crew as well as for dozers.
13. It is always better to blast both benches of dragline in vertical tandem in one go. This will reduce the idle time for unproductive activities like shifting, marching, re-shifting, drilling twice, etc.
14. The swing angle for key cut is taken as 90°.
15. The swing angle for box cut is taken as 120 degrees.
16. The swing angle for re-handling is taken as 90°.
17. Therefore the productivity of dragline will differ for key cut, box cut and rehandling.
18. Coal exposure (million tons) = L * W * H * g * MF * BF
Where,
   L = solid advance of the dragline engaged in exposing coal (m)
   = (Solid productivity of dragline engaged in exposing coal (million Cum))/
     (cross sectional area of volume which is handled by the dragline
      engaged in exposing coal (square meter))
   W = cut width (m)
   H = height of the coal seam (m)
   g = specific gravity of coal
   MF = mining factor (for rib and other operational losses) = 0.9
   BF = band factor

DIFFERENT WORKING PARAMETERS FOR DRAGLINE
1. HEIGHT OF THE BOTTOM DTRIPPING BENCH

Height of bottom stripping bench-overlying coal seam depends primarily on the requirement of coal output and, in turn, this becomes an important factor in deciding the workload for dragline and shovels. It is to be noted that dragline has its limitations depending upon its designed parameters and, therefore, the more is the OB thickness, the increased workload is for the shovel.

As OB thickness increased beyond the limitation of dragline, there is no alternative to shovel-dragline combine working systems. Operational planning assumes much significance in this case and strategy has to be de-coaled on distributing the workload for dragline and shovel, quantity of OB possible to be accommodated in de-coaled area and at the same time keeping the re-handling percentage minimum. The problem becomes more complex in case multi-seam working has to be carried out. It is to be appreciated that dragline has independent working but shovel workings depends also on mode of transportation.

2. WIDTH OF DRAGLINE CUT

The following points should be considered while deciding the width of cut:

1. Deployment of single shovel or double shovels for extraction of coal.
2. Percentage of rehandling.
3. Deployment of draglines in horizontal tandem or vertical tandem.

In case, deployment of draglines in horizontal tandem and two shovels for extraction of coal is a necessity, width of the dragline cut has to be kept more for smooth and safe operation.

3. DRAGLINE IN TANDEM-VERTICAL OR HORIZONTAL

Dragline operation in vertical tandem may be considered in the following conditions:
1. Where the OB thickness to be handled by dragline is more than the effective and efficient digging depth of dragline.
2. Bench height is limited by drilling depth of the drilling rigs.
3. Dumping height poses no problem for dragline deployed at lower bench due to accommodation of material.
4. Increased rate of coal exposure is required and thickness of dragline bench is to be kept less.
5. Shovel capacity is not matching with dragline capacity and unable to provide sufficient working space for the dragline.

Horizontal tandem operation of dragline is deploying draglines at the same level has been added advantages in the under mentioned conditions:

1. Increased width of the dragline cut is possible which will reduce idle time for marching and power shut down.
2. Area of operation of both draglines is concentrated and thus better supervision is possible.
3. Due to increase OB bench thickness, dumping height for the lagging dragline, which is exposing coal, poses no problem.
4. Marching of the dragline at the end of the cut is easier than in vertical tandem because dragline will be sitting at a higher level.
5. Productivity is increased due to less swing angle and less problem due to dumping height.

4. KEY CUT
The key cut is taken along the high wall.

Advantages of key cut:
1. The high wall is cleaned and dressed, so that there is no danger of looming loose and Boulder (this is also a recommendation of the inquiry committee of the accident of PH3 at Dudhichua project)
2. The swing angle of working of dragline while key cutting operation is 90° or <90°.
3. If the situation demands for extending bench method, the material of key cut is used for extending the bench.

Disadvantages of key-cut
1. The reach of the dragline is limited as the dragline is sitting along the high wall.
2. If the void available is sufficient and the cut width is less and permit the accommodation of over burden in void, without extending the bench. If key cut material cannot be accommodated without extending the bench, then re-handling percentage increases unnecessarily.
3. Re-handling percentage is more with key cut method, generally for single dragline.

5. Clearance between toes of high wall and dump: This clearance is needed for enhanced safety of coal winning if equipment besides reducing the chances of dilution/contamination of coal. This clearance can be selected as per the requirement.

6. Factor for throw due to blasting: Depending on the blasting parameters and techniques some amount of overburden material from dragline bench is thrown in the pit. A suitable factor which if expresses the amount of through as a percentage of first dig is selected depending on the condition.
7. Annual working hours. After allowing for normal maintenance etc 5229 hours of productive work is expected for the dragline.

8. Mining losses. A general 10% coal loss is incorporated for calculation of production to account for losses in floor, coroners and spillages etc.

9. Swing angle. Angle of Singh is the angle subtended at the centerline of the dragline by the centroids of cuts and dumps created by this dragline. Effective swing angle is the weighted average of the swing angle from different position of the dragline during operation.

Annual productivity-swing angle is one of the most important factors affecting annual productivity of the machine. This reduces as swing-angle is increased and vice versa. Productivity is reduced in the chop down mode of operation, as is the peace in top-dig and advance benching in during re-handling productivity increases, as digging is easier.

Category of rocks

The rocks handled by dragline have been broadly classified into five categories depending on their mechanical properties. The overburden, which is removed by the dragline, can belong to a single category or a combination of more than one. While swell-factor and the excavation cycle-time are functions of the type of soil, the fill factor is a function of the type of rock handled and the bucket capacity.

Prevention of accident along the high wall.

1. For better safety, dragline has to cut a key cut parallel to the high wall to give a cleaner high wall side.
2. A corridor along the dragline cut almost 20 m., wide has got to be maintained.
3. Survey control systems may be introduced to monitoring the drilling pattern and back row has to be drilled in straight lines so that the high wall is straight as far as possible and gives a place for dragline to maintain a clean high wall. Even on the whole bench the blasting along the high wall has to be controlled so that no ledge is left out and coal face on the high wall side also remains as solid as possible.
4. Where there is a slip in a coal seam, a special care in the blasting is needed.
5. High wall coal cleaning should proceed along with the main bench coal winning. Leaving long ledge creates more adverse condition and thereby allowing coal ledge to fall down due to almost daily blasting operations in the mine.
6. Shovel should not be placed parallel to the high wall; and to close to it. Wherever cleaning is needed on the high wall side, the bucket should be placed at 90° from the high wall.
7. Refreshing training for the supervisory staff and operating personnel has to be given with a specific reference to this incident.
8. Coal should be extracted in two benches whenever the seam thickness is more than the permissible digging height of the equipment.

PLANNING FOR DUMP-ACCOMODATION OF OVERBURDEN

Deciding the strategy for accommodation of overburden in an important aspect of operational planning. This is particular significant for shovel-dumper combination working, space available for accommodation are –
1. External dump – area beyond the limit of coal winning.
2. Internal dump – area over dragline dump.
3. Dumping in decoaled area, created by previous dragline cut.

The following factors need consideration while designing for dump.

1. Dump should be planned in benches for proper reclamation.
2. Dumping over dragline dump should be limited to area beyond the last two cut to ensure stability.
3. Alluvial soil should not be dumped at the floor of the dump to ensure stability.
4. Casting by shovel and dumper should be limited to designed level otherwise will create problems for dragline working and stability of dump.
5. Wherever possible, dump should be designed to have minimum possible load for dumper to increase its productivity.
6. Width of the previous cut should be taken into account while designing for dump.

**DUMP IN DECOALED AREA**

While doing operational planning, it is significant to decide the quantity of OB that can be accommodated in the decoaled area created during previous cut. This can be decided in terms of OB thickness above coal top to be accommodated in the area available. This will also help in deciding how much OB thickness, excavated by shovel and transported by dumper can be accommodated in the decoaled area. This accommodation will help in increasing the productivity of shovel-dumper combination by reducing the lead for dumper movement.

Accommodation of OB will depend basically on three factors:

1. Seam thickness – the higher seam thickness, more availability of accommodation area.
2. Reach of the dragline – depending upon designed parameters.
3. Designed dump slope to ensure stability of dump.

In case, it is possible to accommodate more OB thickness than dragline bench, shovel can be direct casting (again limited by reach of shovel) and thus further improving the productivity of shovel.

It should be always kept in mind that accommodating OB more than the designed thickness would create problems for dragline working and increase rehandling percentage.

**DRILLING PLAN**

In dragline mining system, maintenance of the line of face in the designed direction is essential for smooth working of dragline as well as coal shovels. Drilling plan acts as an important tool. Drilling plan should indicate –

1. Direction of the working face both for OB shovels and draglines.
2. Existing level and the level required for different benches.
3. Depth of drilling including sub-grade drilling.
This drilling plan should be handed over to operators, supervisors and surveyor for operation and monitoring. It should be appreciated that maintenance of working face is necessary from top of the shovel benches than only direction for the dragline working can be mentioned.

**SCHEDULING OF EQUIPMENTS DEPLOYMENT**

Scheduling of equipment deployment is key to the success of an operational plan. This scheduling should be realistic and based on the past performance while taking the productivity norms of the equipments into account. The operational plan will loose its significance if the productivity norms are hypothetical.

The scheduling keeps in monitoring the working of the mine and strategy has to be changed by re-scheduling in case any equipment undergo major breakdown.

**PLANNING FOR MONSOON**

In India, rainy season (June to September) is loan period for production and involves additional work both in planning and implementation. To add duel to the fire, the period is proceeded by summer season (temperature as high as 45°C in April & May) in which preparatory works for monsoon have to be completed. It is suggested that operational plan should be made ready well in advance so that some of the preparatory works, such as garland drains, pipe laying, Mid-sump preparation and cleaning are completed by end of April and only those works are left which are dependent on mining operation.

The operational plan for monsoon should indicate –

1. The course of drainage.
2. Existing level and the level required.
3. Position of the sump.
4. Garland drains, if repaired and quantity of the material to be evacuated.
5. Position of mid-sumps to arrest water so that minimum quantity of water reaches to the cut sump.
6. Position of sidewalls repaired for preventing siltation.
7. No. of pumps and pipeline ranges required depending on past experience.
8. Design of road for movement of dumpers.
9. Position of hume pipe culverts, if required.

Operational planning for monsoon particular attention in:

1. Deciding the schedule for deployment of shovel and dragline so that coal is exposed well in advance and extraction of coal is completed by middle of May to give sufficient time for pump installation.
2. Deciding the level of road and the thickness of coal to be extracted so that heavy rainfall does not submerge the road and the coalface.
3. Deciding the strategy to meet the target of coal production.

It is suggested that in multi-seam working, higher rate of coal production should be planned from top seams. Coal extraction from bottom seam poses problems in rainy season.
Surface mining:

1) Open Pit mining
2) Opencast / strip mining

OPEN PIT

SMALL CAP ANCILIARY EQUIPMENTS

SHOVEL DUMPER

OPEN CAST

S/D+D/L

DRAGLINE

SINGLE D/L

MULTI D/L

SAME CAPACITY

DIFF. CAPACITY

SIMPLE SIDECASTING

EXTENDED BENCH

HORIZANTAL TANDEM

VERTICAL / REAL TANDEM
HAUL ROADS:

Haul road forms the lifeline of the opencast mining Project. These roads are used by HEMMs mainly for hauling of OB and Coal. Haul roads becomes potentially hazardous area in dumper application if they are not designed, constructed & maintained properly. Majority of the accidents in opencast mines take place in haul roads & associated roads. The important considerations of haul road design related to safe operation of dumpers are:

- Design of horizontal & vertical curves
- Design of super elevation
- Design of width
- Design of grade
- Road surface
- Haul road drainage
- Haul road lighting
- Adequate & regular maintenance of haul roads
- Proper sign boards & hazard lights

The curves should be so designed that a dumper can see another dumper or any obstacle on the road at a distance more than stopping distance.

The super elevation at the curve shall be so designed that it gives the maximum stability to the turning dumpers.

For safety, haul road grade must be designed to accommodate the braking capabilities of the vehicles, having the least braking potential.

Arresting berms should be provided on haul roads & ramps. Haul roads should be as straight as possible. When the haul roads are not properly maintained, then the dumper operators may suffer from back-injury. Moreover bad haul roads may lead to loss of traction, which may be hazardous.

Types of the haul roads:

1) Permanent Haul roads
2) Haul roads connecting the Permanent haul roads to faces & dumps.
3) Ramps connecting different benches.

1) Permanent Haul roads: In the Project report provisions are made towards construction of haul roads. Since the orientation/alignments and the lengths of the haul road change considerably with the advancement of quarry operations, estimates for the portion of the haul roads and other roads, which
are to be maintained for the life of the project, are provided. These may be termed as permanent haul roads. Since haul roads are considered to be the permanent source of dust in opencast mines, construction of haul roads with flexible pavement reduces pollution of environment from dust to a considerable extent. The road alignments are also used by crawler-mounted equipments like dozers. Since plying of crawler-mounted equipments is likely to damage the flexible pavement, a 5-meter wide flank has to be kept on one side of the flexible pavement for use by such equipments. Haul roads should be designed according to appropriate specification, taking into consideration the weight and the amount of traffic. Otherwise, the road surface is likely to develop unequal subsidence; making maintenance different and increasing the costs of haul road maintenance.

Determination of thickness of Flexible pavement:
Gray’s Formula –  
\[ d = 0.564 \frac{W}{B} - L \]
Where,
- \( d \) - thickness of Flexible pavement in inches
- \( W \) - Static wheel load in lbs. = 1.2 X load per pair of wheel
- \( B \) - Bearing value of the ground in lbs/Sq. Inch (CBR value)
- \( L \) - radius of equivalent area of tyre contact = contact area of tyre.

The maximum wheel load (load per tyre) for a double-axle vehicle should be increased by 20% extra for Impact

Example

Preconditions:

Dump Truck used : KOMATSU HD 785
Hauling capacity : 78 tones
Gross Hauling capacity : 129,555 kg
Front axle load : 41,855 kg
Rear axle load : 87,700 kg
Soil conditions : CBR = (silty clay)

Calculation method:

Maximum wheel load : 21,925 x 1.2 = 26,310 kg
From figure the intersection of 26,310 kg and CBR = 5 lies at a depth of 81 cm.
Sandy soil with a CBR of about 15 can be used as the sub base material, and the intersection lies at a depth of 40 cm.
Gravel with a CBR of about 80 can be used as the base and the intersection lies at a depth of 18 cm.
Good quality (fine) crushed rocks (CBR = 80) can be used for the road surface.
DGMS GUIDE LINES (PERMISSION) FOR HAUL ROADS

2) All roads for truck, dumper or other machinery shall be maintained in good condition.

3) All roads from the OC workings shall be arranged to provide one-way traffic. Where this is not practicable, no road shall be of a width less than three times the width of the largest vehicle plying on that road unless, definite turn outs and waiting points are designated.

4) All corners and bends in the roads shall be made in such a way that the operators and drivers of the vehicles have clear view for a distance of not less than 30 meters. Along the road and be provided with proper parapet wall or road dividers etc.

5) No road shall be steeper than 1 in 16 at any place, except in cases of ramps over shall patches which may be up to 1 to 10.

6) Where any road exist above the level of the surrounding area, it shall be provided with strong parapet walls or embankments not less than one meter in height to prevent any vehicle from getting off the road. Same type of embankment shall be provided on coal/OB stockpiles/dumps (in addition to the spotter/supervisor).

Provisions of Coal Mines Regulations, 1957:

Section 95 A. Roads for trucks and dumpers:
1) All roads for trucks, dumpers or other mobile machinery shall be maintained in such conditions as to be fit for their use.
2) Except with the express permission of the Chief Inspector in writing and subject to such conditions as he may specify their in, no road shall have a gradient steeper than 1 in 14

HAUL ROAD EQUIPMENT & ORGANISATION:

1. Equipment

(a) Graders:

The compaction level and smoothness of the roads have to be maintained such that the haul roads are able to absorb the moving weight of fully loaded 120T dumpers weighing about 200T gross. The 110HP Graders are too light for such job requirement. Graders of 200HP or more are required to undertake for the purpose.

FE Loader

Front End Loaders are required for loading road repair material for maintenance and for general clearing up works.

Tipping Truck:
Tipping trucks are to be provided to work in conjunction with the front-end loaders for transport of filling material repairing and maintaining gravel topped roads.

(d) Hydraulic Excavator

Hydraulic Excavator with backhoe attachment is required for cutting and maintaining haul roads drains and clearing of culverts to avoid water logging anywhere on or near the roads facilitating the mine operation even in monsoons.

Tyre mounted Dozer:

Tyre mounted dozer is much faster and more versatile for light jobs like spreading and cleaning and damage to roads due to track chain of the dozers shall be avoided.

2. Organisation

Separate organisation and equipments for Haul Road must be made, headed by a senior person of E4/E5 rank directly under Mine Manager.

**OPENCAST WORKINGS**

Height and Width of Benches

(a) Height of benches shall not exceed the maximum reach of the machine used for digging excavation or removal.

(b) Unless otherwise permitted by the Regional Inspector of mines (now designated as Director of Mines Safety) by an order in writing, the width of bench shall not be less than twice the diameter of the turning circle of the largest machine working on the benches.

Provided, that where there is one way traffic over the benches, the width of a bench may be reduced to not less than twice the length of the largest machine working on the bench.

**DGMS PERMISSION FOR WORKING OPENCAST MINES WITH HEMM**

Permission for exemption from the provisions of Regulation 98 (1) & (3) of the Coal Mines Regulations, 1957 for working opencast mines with the help of Heavy Earth Moving machineries in conjunction with a system of deep shot hole blasting subject to the following conditions being strict complied with:

No topsoil, clay, alluvium or black cotton soil shall be dumped so as to form the base of the internal overburden dump. Such materials, if any, shall be dumped only on top of the internal overburden dump.

The width of the cut taken by the dragline in overburden shall as far as practicable be maintained constant throughout the face so that the alignment of the coal face and the toe of the internal overburden shall run parallel to each other.
The coal/overburden face shall be laid so that any make of water at the overburden/coal face or in the dump shall gravitate unhindered automatically towards the sump located at the centre of the face (s) or the out bye end of the face as the case may be. The gradient along with floor of the coal seam or the bed rock shall be maintained preferably 1 to 70 but in no case shall be less than 1 in 80 towards the central sump.

Where the inclination of the bedrock does not exceed 5 degree from the horizontal, the height of overburden dump nearest to the coalface shall not exceed 60m. A bench 10-15m. Vide in the overburden shall be maintained between this dump and the final dump created by the dragline.

If the inclination of the bedrock exceeds 5 degree, the height of the fore bank shall be suitably reduced.

**Fencing around the Opencast Working**

(i) Unless otherwise permitted by the Regional Inspector of mines (now designated as Director of Mines Safety) by an order in writing subject, to such conditions as he may specify therein the top edge of the opencast working shall be kept fenced with wire ropes, i.e. wire rope strands or barbed wire, supported by movable post stands (wooden, iron or concrete). The gap between the adjacent rope strands or wires shall not be more than 0.30 meters and the bottom most rope, strand or wire shall not be more than 0.25 meters and the top most rope, strand or wire shall not be less than 1.00 meters from ground level.

(ii) At the finishing stage the opencast working shall be fenced with a masonry wall in lime mortar, not less than 0.40 meters thick and not less than 1.2 meters height, with a parapet top.

**Operation plan preparation**

First of all the capacity assessment of the mine is done.

**Shovel dumper capacity**

**Dragline**

The total capacity of dragline is fixed, it comprises of solid and re-handling, as the dragline has also to re-handle certain amount of over Burden in most of the cases. The percentage of total capacity of draglines to be used for re-handling depends upon many factors.

1. Method of working.
2. Variables in dragline working.
   A. Machine variables.
   B. Geo mining conditions.
   C. Operational variables.

To maximize the gainful utilization of dragline these re-handling percentage has to be kept minimum in a given situation.

To minimize the re-handling percentage the drawing of balancing diagram is necessary.

Balancing diagram is nothing but graphical representation of the cross section of the directory working. If

As the name suggests, the over Burden to be removed by the dragline shall be balanced in the available void, of previous cut, such that the re-handling percentage is minimum, the internal dump is safe and stable, and least susceptible to failure.

How to draw balancing diagram?
Spoil Banks:

(i) (a) The slope of a spoil bank face shall be determined by the natural angle or repose of the material being deposited, but shall in no case exceed 37 degrees from the horizontal.

(c) The spoil bank face shall not be retained by artificial means at an angle in excess of its natural angle of repose.

(ii) (a) The toe of a spoil bank face shall not be to approach a railway or other public works, public roads or building or other permanent structure not belonging to the owner of the mine, closer than a distance equal to the vertical height of the face.

(b) A suitable fence shall be erected between any railways or public works or road or building or structure and the toe of an active spoil bank so as to prevent unauthorised persons from approaching the spoil bank.

(iii) No person shall or shall be permitted to approach the toe of an active spoil bank where he may be endangered from material rolling down the face.
### Compressive Strength Kg/Cm²

<table>
<thead>
<tr>
<th>CATEGORY OF ROCK</th>
<th>BLASTING REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP TO 55</td>
<td>NIL</td>
</tr>
<tr>
<td>55-125</td>
<td>LIGHT</td>
</tr>
<tr>
<td>125-250</td>
<td></td>
</tr>
<tr>
<td>250-1250</td>
<td>FULL</td>
</tr>
<tr>
<td>&gt;1250</td>
<td></td>
</tr>
</tbody>
</table>
32 CuM BUCKET

4 CuM BUCKET

I  II  III  IV

180 DEGREES SWING ANGLE

120 DEGREES SWING ANGLE

I  II  III  IV
## ANNUAL PRODUCTIVITY OF WALKING DRAGLINES AND VARIABLES FOR ITS CALCULATION

<table>
<thead>
<tr>
<th>BUCKET CAPACITY</th>
<th>50 % Cat.III + 50 % Cat IV</th>
<th>90 % Cat.III + 10 % Cat IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SWELL FACTOR</td>
<td>BUCKET FILL FACTOR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>0.719</td>
<td>0.867</td>
</tr>
<tr>
<td>5.0</td>
<td>0.719</td>
<td>0.871</td>
</tr>
<tr>
<td>6.1</td>
<td>0.719</td>
<td>0.874</td>
</tr>
<tr>
<td>6.9</td>
<td>0.719</td>
<td>0.877</td>
</tr>
<tr>
<td>8.4</td>
<td>0.719</td>
<td>0.883</td>
</tr>
<tr>
<td>10.0</td>
<td>0.719</td>
<td>0.888</td>
</tr>
<tr>
<td>11.5</td>
<td>0.719</td>
<td>0.894</td>
</tr>
<tr>
<td>12.0</td>
<td>0.719</td>
<td>0.896</td>
</tr>
<tr>
<td>14.0</td>
<td>0.719</td>
<td>0.903</td>
</tr>
<tr>
<td>15.0</td>
<td>0.719</td>
<td>0.906</td>
</tr>
<tr>
<td>16.0</td>
<td>0.719</td>
<td>0.910</td>
</tr>
<tr>
<td>20.0</td>
<td>0.719</td>
<td>0.924</td>
</tr>
<tr>
<td>24.0</td>
<td>0.719</td>
<td>0.938</td>
</tr>
<tr>
<td>26.0</td>
<td>0.719</td>
<td>0.946</td>
</tr>
<tr>
<td>27.0</td>
<td>0.719</td>
<td>0.949</td>
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<tr>
<td>29.8</td>
<td>0.719</td>
<td>0.959</td>
</tr>
<tr>
<td>31.0</td>
<td>0.719</td>
<td>0.963</td>
</tr>
<tr>
<td>32.0</td>
<td>0.719</td>
<td>0.967</td>
</tr>
</tbody>
</table>
## WORKING RANGES OF W-2000 DRAGLINE

<table>
<thead>
<tr>
<th>BOMM LENGTH (m)</th>
<th>OPERATING RADIUS (m)</th>
<th>BOOM ANGLE (DEG)</th>
<th>MAX. SUSPENDED LOAD</th>
<th>BOOM LENGTH (m)</th>
<th>DIGGING DEPTH (m)</th>
<th>DUMP HEIGHT (m)</th>
<th>HOIST</th>
<th>DRAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>74.6</td>
<td>64.0</td>
<td>38</td>
<td>102100</td>
<td>51.9</td>
<td>50.5</td>
<td>34.4</td>
<td>2.39</td>
<td>2 X 70</td>
</tr>
<tr>
<td>74.6</td>
<td>70.0</td>
<td>30</td>
<td>102100</td>
<td>43.0</td>
<td>56.5</td>
<td>25.5</td>
<td>2.39</td>
<td>2 X 70</td>
</tr>
<tr>
<td>85.1</td>
<td>72.5</td>
<td>38</td>
<td>98400</td>
<td>58.1</td>
<td>46.2</td>
<td>40.6</td>
<td>2.39</td>
<td>2 X 70</td>
</tr>
<tr>
<td>85.1</td>
<td>79.0</td>
<td>30</td>
<td>86200</td>
<td>48.4</td>
<td>55.7</td>
<td>32.3</td>
<td>2.39</td>
<td>2 X 70</td>
</tr>
<tr>
<td>95.6</td>
<td>81.0</td>
<td>38</td>
<td>83500</td>
<td>64.3</td>
<td>67.5</td>
<td>48.1</td>
<td>2.59</td>
<td>2 X 70</td>
</tr>
<tr>
<td>95.6</td>
<td>88.0</td>
<td>30</td>
<td>77000</td>
<td>53.9</td>
<td>74.5</td>
<td>38.2</td>
<td>2.59</td>
<td>2 X 70</td>
</tr>
</tbody>
</table>

- CENTRE OF ROTATION TO BOOM FOOT: 4.1 m
- BOOM FOOT TO GROUND: 5.8 m
- REAR END CLEARANCE RADIUS: 20.88 m
Composite OMS (Cu.M.) = \{\text{Composite Production (in Cu.M.)} / \text{Manshifts excl. area office}\}

OMS (Tes) = \{\frac{(\text{Coal (Tes)} + \text{Sp.Gr. x OB})}{(\text{Manshifts excl.area office}) \times (1 + \text{Sp.Gr. x A.S.R.})}\}

Adj. Manshifts =