RISK ASSESSMENT AND DISASTER MANAGEMENT

DEGREE OF GASSINESS

The project report has been drawn in conformity with the prevailing statutory provisions as per Mines Act 1952 and CMR 2017 applicable for safety in Opencast Mines. However, all statutory rules, regulations, applicable laws etc. and statutory requirement related to Govt. licenses, workers compensation, Insurance, etc. including minimum wage act/CIL High Power Committee wages for workers employed by the agency outsourcing HEMM shall have to be adhered to. All the regulations & schedules of coal mines Regulations 2017 relating to opencast mining have to be adhered to and implemented in order to maintain day to day safety precautions as per statute.

INUNDATION

Chandrabhaga river is flowing in the dip side of property, through Silori Block. A Seasonal Nala is flowing over the property, which is proposed to be diverted in this report. It is proposed in the project report to construct a flood protection embankment along the dip side quarry surface limit to prevent water from the nala & river. Surface water would be channelized through proper garland drains.

Another Kolar river is flowing in the rise side (North-East) of mine at about 1.5-2.0 km from the proposed surface edge of quarry. OB dumping has been proposed in the rise side of the quarry on non-.coal bearing area and therefore separate embankment has not been proposed against Kolar River. However, if required, an embankment may have to be constructed against Kolar River.

As per prevailing practice, proposed embankment has to be constructed by spreading the suitable soil i.e fine grained soil for Hearting zone and coarse grained soil for casing zone in continuous layers and compacted by mechanical means i.e. by rollers to standard optimum dry density at optimum moisture content. However before adoption of this section it is suggested that the proposed embankment section may be got approved by competent authority like Maharashtra Irrigation department of Govt. of Maharashtra and DGMS for its structural safety and stability. The alignment of the proposed embankment is shown in Quarry & Surface Layout Plan. It is also suggested to determine withdrawal level/Danger mark, so that as water level crosses the limit, workings shall be stopped.

The rain water falling within the project area would be diverted from the quarry area by providing garland drains and shall be collected towards low lying area.

FIRE AND SPONTANEOUS HEATING

The project report proposes extraction of standing pillars of seam-IVM and seam IVB of Adasa UG mine by opencast method. The incubation period of this coalfield is reported to vary between 3 to 6 months. There may be spontaneous heating of coal in underground galleries near the quarry coal face due to leakage of air and fire may broke-out as soon as these galleries are exposed. It is proposed to lay water pipeline along the strike length on the dip side of quarry so that flexible hoses can be taken out from `T' points of the pipeline for immediate quenching of the fire in coal galleries/pillars. In addition to this, a fire retardant Bitumen based sealant which is in the approved list of DGMS can be used in the coal benches to minimize leakage of air and thereby reduce incidence of occurrences of fire due to spontaneous heating.

Use of OB as blanketing material will also be tried whenever possible to fight fire. Necessary precautions must be taken while re-handling the hot OB which was used for blanketing. While extracting pillars by opencast method, precautions against coal dust explosion as specified in DGMS Circular No.-4 of 1983 should be adhered to.

Wild or herbaceous plants shall be removed from the mine. No person shall deposit heated material or ashes on any opencast working. No person shall light a fire or permit a fire to be lighted in any OC working except by the permission in writing of the Manager and only for a special purpose specified therein. No coal shall be left exposed in coal benches more than its incubation period to avoid fire in seam due to spontaneous heating. Proper type of the extinguisher should be kept in each HEMM ready for use in case of emergency. In coal stock, coal shall be dispatched on the basis of first in first out.

SLOPE STABILITY

It is suggested that following action may be taken to deal with slope stability problem.

i) Vulnerable area may be identified and marked on quarry plan.

ii) Observation of actual alignment of fault, its throw, joints, etc. may be recorded during the process of exploitation.

iii) Water drainage system may be properly implemented to prevent accumulation of water in cracks. Also dumps shall be leveled to prevent accumulation of water over it. Proper drainage in dumps shall be also

provided to prevent erosion of toe of dump.

iv) Regular monitoring of tension cracks, horizontal and vertical movement of strata in critical area may be done.

v) Rise side slope to be reinforced if required because it has to stand throughout quarry life. No dumps/surface structures to be located within 15m of quarry edge as it will act as surcharge there by destabilizing the slope.

vi) No undercutting of slopes to be done.

vii) Proper hydrogeological studies to be done if water table is at level of slope it should be brought down by using submersible pumps to prevent hydrostatic pressure.

viii) Proper selection of site for dumping to be done before dumping place shall be made free from loose material. Dumping shall not be done at an angle more than angle of repose of material being dumped.

ix) After completion of dumping operations dumps to be stabilized by growing vegetation.

x) Every person deployed by leaser of HEMM must be trained & briefed about aspects related to slope stability.

STABILITY OF DUMPS

Coal Mines Regulation, 2017 provides for precautions to be taken for Spoil banks and dumps in Regulation no. 108 and Circular No. DGMS(Tech.) (S&T) Circular 2 Dhanbad, dated 20/6/2001. The provision in Regulation is as following:

Spoil banks and dumps (Regulation 108)

(1) While removing overburden, the top soil shall be stacked at a separate place, so that the same is used to cover the reclaimed area.

(2) Slope of a spoil bank shall be determined by the natural angle of repose of the material being deposited, but shall in no case exceed 37.5 degrees from the horizontal. The spoil bank shall not be retained by artificial means

at an angle in excess of natural angle of repose or 37.5 degrees whichever is less.

(3) Loose overburden and other such material from opencast workings or other rejects from washeries or from other source shall be dumped in such a manner that there is no possibility of dumped material sliding.

(4) Any spoil bank exceeding 30m in height shall be benched so that no bench exceeds 30m in height and the overall slope shall not exceed 1 vertical to 1.5 horizontal.

(5) The toe of a spoil-bank shall not be extended to any point within 45 m of a mine opening, railway or other public works, public road or building or other permanent structure not belonging to the owner.

(6) A suitable fence shall be erected between any railway or public works or road or building or structure not belonging to the owner and the toe of an active spoil bank so as to prevent unauthorized persons from approaching the spoil-bank.

(7) No person shall approach or shall be permitted to approach the toe of an active spoil bank where he may be endangered from material sliding or rolling down the face.

(8) Adequate precautions shall be taken to prevent failure of the slopes of the spoil banks or dumps.

Following precautions are required for stability of OB Dumps

1. Dumping Site Selection

Usually, ground close to the mine is selected for dumping in surface mines. However, suitability of site should be evaluated before construction of dump to ensure the stability. If the site is not suitable from the point of view of stability then alternative site may be explored, or else some site preparations should be undertaken for making it suitable for waste dumping.

Following factors should be considered while selecting the dumping site:

a) Size of the area,

b) Presence of infrastructural and other features,

c) Topography and landforms,

d) Soil characteristics,

e) Rain Fall,

f) Hydrology, and

g) Regional seismicity.

2. Stability of OB Dumps

The stability of dumps must be carefully evaluated and monitored during the operating phase of the mining. The OB dump slopes are usually designed with substantial factors of safety and there is usually little risk of failure.

The long term stability of OB dump slopes can decrease as a result of:

(i) Increase in the groundwater table due to groundwater accumulation and due to changes in the permeability of the dump materials resulting from weathering and the in washing of fines,

(ii) Decrease in the dump material strength due to weathering.

3. Methods of Improving Stability of OB Dumps

Many methods have been used in geotechnical engineering for stabilization of landslides. The legislative and environmental requirements of most countries stress on stability of dumps to protect the environment and for safety of land, building and mankind. But the legislative controls cannot adequately detail the procedures to aid mining personnel or regulatory agencies in identifying potential stability problems. Moreover, stability problems are often site specific and require individual attention. Any legislative control cannot preclude the failure of spoil dumps altogether. The various methods for improving the stability of waste dumps are as follows:

- Modification of spoil pile configuration (berms, slope stepping, slope flattening etc.
- Drainage by horizontal and vertical drains, sand drains, relief wells, diversion ditches etc.
- Improvement of spoil strength by compaction, zonation etc.

- External buttresses, berms, in situ coal wedge etc.
- Vegetation.
- Soil reinforcement techniques-Geotextiles, geogrids.

All the stabilization techniques mentioned above function by either increasing resistance forces or decreasing driving force in a potentially unstable slope.

i) Modification of spoil pile configuration

The flattening of slope or provision of berms is generally attempted to increase the stability of dumps by reducing the driving forces in the slope. Reduction of dump height is the last alternative to enhance stability.

ii) Drainage

The influence of groundwater seepage in the slope or in combination with other actions, is the most common cause of slope failure in temperate and humid regions all over the world. The weakening of moisture sensitive material at the base of the spoil pile or spoil material often initiates instability in wet, saturated dumps.

Drainage reduces the hydrostatic and seepage forces on the slope as well as the risk of erosion and piping and, therefore, stabilizes slopes. The intent of drainage is to limit the amount of water in the spoil and/or underclay, thereby enhancing stability or expedite the consolidation. Drainage may be accomplished by providing drainage ditches, granular basal drains beneath the spoil pile, horizontal and vertical drains, relief walls beneath saturated spoil pile or rarely by sand drains, sand wicks and electro-osrnosis.

iii) Vegetation

Revegetation is one of the widely used technique for controlling erosion and stabilization of dump slope, and thereby maintaining ecological equilibrium in the area. Role of vegetation growth upon dump slope can be described as hydrogeological and mechanical actions. With respect to the hydrogeological action, roots of vegetation play an important role in enhancing the dump stability by controlling interception of rain water and evapotranspiration and the resulting pore pressure reduction. Whereas mechanical action in turn, reinforced the dump material by roots and enhanced the shear strength of dump material. This action is closely related to root density, depth and strength. The small roots of vegetation mobilize their tensile strength by increasing soil-root friction of the compound matrix (soil-fiber), whereas, the large size

roots intersect the shear plane; act as individual anchors and eventually tend to slip through the soil matrix without breaking, mobilizing a small portion of their tensile strength. The role or effect of smaller plants in stability of slopes is different from that of the large plants. The roots of smaller plants (such as grasses and shrubs) do not go very deep, however, it stabilizes the slope by binding the upper layer of slope. It also prevents the rain water from infiltrating into upper layer of slope thereby preventing material strength loss. The roots of the large plants (such as trees) go deeper into the slope and act as permanent stitching material. It increases the shear strength of dump mass in general and weakness joint planes in particular. However, tree takes longer time to grow and significantly contribute in slope stability.

Vegetation is multifunctional, relatively inexpensive, self repairing, visually attractive, and does not require heavy or elaborate equipment for installation. However, there are certain limitations. Vegetation is susceptible to blight and drought. It is difficult to get established on mine waste dumps and steep slopes. It is unable to resist severe scour and is slow to become established. It provides only surface stability, deeper level stability is difficult. Therefore, this is not practiced in isolation today due to several uncertainties. But the method offers several environmental benefits.

iv) Geosynthetically reinforced slopes

Geosynthetic soil reinforcement is another technique used to stabilize slopes in civil engineering applications, particularly if steeper and higher slope is desired. In addition, it can improve compaction on the edge of the slope.

In the establishment and associated construction work abroad, Geosynthetics have proven to be successful in a wide range of applications. For example, geotextiles are not used to assist in construction of access roads, site preparation, haul roads and in connection with the construction of embankments for storage ponds and dams as well as for general hydraulic and foundation engineering problems. However in India, they have not been tried in coal mines for dumps stability improvement, though their use is common in civil engineering.

Soil reinforcement using high tensile strength inclusions can increase the shear resistance of a soil mass. This strengthening permits construction of soil structures at slope angles greater than the soil's angle of repose and/or greater than would be possible without the reinforcement.

Geogrid is a variant of geosynthetics. Geogrids are placed in layers during construction to intercept and stabilize potential slip surface. Geogrid soil reinforcement imparts tensile strengths to the soil, thereby increasing the overall factor of safety of slopes against sliding or rotation.

4.0 Monitoring

4.1 Deformation as an Indication of Failure

Deformation occurs in a slope as a result of stresses and shear displacement in the mass of material forming the slope. Some of these deformations, such as consolidation are not indicative of failure while others, such as shear displacement along the failure surface are indicative of failure. To predict failure, it is necessary to distinguish deformations which indicate failure from those which do not. This requires and understanding of the failure mode and the deformations that accompany it.

Failure criteria are usually based on experienced gained as the dump is constructed. The rate of deformation and a change of the rate of deformation are generally good indicators of the behavior of a slope. They may be used to establish criteria indicative of failure.

The slices method of limiting equilibrium analysis may be used to obtain an estimate of the stresses which occur along a failure surface and to determine which portion of the failure surface is in failure. Knowing the stresses and the zones in failure, the nature of the deformations that will result can be inferred.

This inference may be used to design a monitoring system and to interpret the results of deformation monitoring.

4.2 Considerations in Dump Monitoring

i) Failure starts in the zone below the crest. Failure progresses towards the toe which fails just before general slope failure. Deformations at the top of the slope therefore occur during the entire process of failure surface development while those at the toe are most pronounced just before failure occurs. This implies a longer period of warning from monitoring at the crest than the toe but with more "noise" and a less precise indication of the ultimate failure. The warning signal at the toe is more distinct but may occur too late to be of value.

ii) The mobilization of failure conditions on a portion of the potential failure surface does not necessarily imply dump failure. Thus large deformations can occur at the crest with perfectly satisfactory dump performance. The same cannot be said for the toe area.

iii) Deformations at the dump crest due to settlement and consolidation can, to some degree, be separated from shear deformations as a result of the greater amount of horizontal movement associated with the latter.

iv) Consolidation settlement usually decrease with time. Where vertical deformations continue at the same rate, or accelerate, after dumping is stopped progressive failure is indicated.

v) Stability analyses often indicate a failure surface which intersects the slope at the crest line. Dump failures of this type are frequently observed. Monitoring stations must be located at the crest or sometimes on the front slope. Monitoring stations located back from the crest are of little value if the failure surface is likely to intersect the crest.

vi) The amount of movement that is likely to occur before failure determines the sensitivity of the monitoring equipment required. Movement varies with the type of dump material, the dump height and the location at which monitoring will be done. Stiff cut rock slopes may fail after a few centimeters of movement and sensitivity to tenths of a centimeter, or less, is required.

HAUL ROAD MAINTENANCE

In the approve Project Report, haul road shall be constructed and maintained from time to time. It will be maintained by hiring agency. Safe distance between the haul road and the toe of the backfill shall be maintained.

BLASTING

This project report proposes extraction of standing pillars of underground mine by opencast. To eliminate the danger due to falling of equipment into the developed galleries, a method of controlled blasting to fill up the galleries will have to be adopted. Suitable precautions would be taken as per statute before and after blasting operations. While working near infrastructure, buildings etc., controlled blasting technique has to be practiced to minimize fly-off rocks and ground vibrations and to

keep them within safe limits. Provision for conducting such scientific studies has been made in this report.

SCIENTIFIC STUDIES

Following areas have been identified in the PR of Adasa UG to OC mine for detailed scientific studies:

a) Slope Stability

It is proposed to carry out scientific study on slope stability of external and internal OB dumps as well as for final slope of quarry batter. Based on the findings of scientific research the proposed slope of dumps and batter in the report may change.

b) Drilling & Blasting

For optimum fragmentation of rock and coal to minimize the overall cost of excavation, it is proposed in this report to engage some scientific body to carry out research for optimum drilling and blasting. Accordingly, the powder factor suggested after this study will be followed in the proposed mine.

c) Hydrogeology

Proper provision has been made in this report for scientific study to assess the hydro-geological parameters of the proposed area.

In addition to this, various other parameters like, soil testing, etc. need scientific study. Adequate capital provision has been made in this report for these miscellaneous studies.

ADDITIONAL PERMISSION / RELAXATIONS REQUIRED FROM DGMS

- **SAFETY ASPECTS FOR OUTSOURCING/HIRING OF HEMM**

Special precaution should be taken while employing contractual labours in the mine. Before employing them to the mine proper vocational training should be imparted and recommendations of Safety Conferences should be strictly followed. Terms and conditions shall be fixed by management for deployment of contractual labours as well as machineries. Some of the major aspects are as follows :

A) For persons :

i) Records in Form-B & Form-E shall be maintained.

ii) Records of driving licence of operators shall be kept by Operators and readily available for inspection by management.

iii) Salaries shall be distributed in front of management representative

iv) No person shall be employed unless person holds VTC certificate and Management is informed.

v) Adequate supervision shall be maintained by competent person.

B) For Machineries :

i) All the machineries to be deployed in mines should be inspected & passed by the management.

ii) RTO certificate photo copies of all vehicles shall be submitted to management.

iii) Daily welding, monitoring, inspection shall be done by contractor's mechanic as directed by management. Machine manufacturers should be asked to give risk analysis.

C) General :

i) No person/vehicle shall be deployed at any place other than authorized place.

ii) All employees of contractors should obey lawful instruction of mine management.

PRECAUTIONS WHILE EXTRACTING U/G WORKINGS

i) All the prevailing statutory provisions, applicable to OC mines, are to be strictly adhered to.

ii) The co-ordinates of each gallery junction must be transferred on mine plan and gallery position should be marked on opencast mine horizon so that while working any mining horizon, the exact position of galleries, the parting between roof of gallery and the opencast mine horizon and other details are known. Thus, the drilling and blasting pattern will vary depending upon the position of galleries.

iii) To eliminate the danger due to falling of equipment into the developed galleries, a method of controlled blasting to fill up the galleries will have to be adopted.

iv) Diesel operated Hydraulic Backhoe will be deployed by outsourcing agency for coal and parting benches so that whenever there is collapse of parting and tilting of machine into gallery then the diesel Hydraulic Backhoe machines can support itself on its bucket and the Operator can come out of the machine safely.

i) While extracting pillars by opencast method, precautions against coal dust explosion, as specified in DGMS Circular No.4 of 1983 should be strictly adhered to. While blasting in hot strata, the precautions listed in DGMS Circular No.2 of 1990 should be strictly adhered to.