JSW Steel Limited

Regd. Office: JSW Centre
Bandra Kurla Complex,
Bandra (East), Mumbai – 400 051
CIN : L27102MH1994PLC152925
Phone : +91 22 4286 1000
Fax : +91 22 4286 3000
Website : www.jsw.in

No. JSW/S/CO/2023/300 Date: 30/05/2023

To,
The Deputy Director General of Forests (C),
Ministry of Environment, Forest and Climate Change,
Regional Office (Eastern Zone),
A/3, Chandersekharpur, Bhubaneswar – 751023

Sub: - Submission of Six-monthly EC compliance report for the **Nuagaon Iron Ore Mine of M/s JSW Steel Ltd for the period Oct 2022 to March 2023.**

Ref: 2. Environment Clearance Letter dated 05.08.2021 for Mines issued by MOEF&CC, GOI.

Dear Sir,

We are submitting herewith six-monthly EC compliance report of Nuagaon Iron Ore Mine, M/s JSW Steel Ltd. for the period Oct 2022 to March 2023 as per EIA notification 2006. The same is also attached in Soft copy to your good office on e-mail to roez.bsr-mef@nic.in; for your ready reference.

We trust that the measures taken towards environmental safeguards comply with the stipulated conditions. We look forward to your guidance which shall certainly help us in our endeavor for improving upon our environmental management practices.

Seeking your co-operation as always.

Thanking you,

Yours Faithfully
For JSW Steel Ltd

Mrutyunjaya Mahapatra

MrutyunjayaMahapatra
(Authorized Signatory)

Encl: As above

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Copy to:
1. Zonal Office Kolkata, Central Pollution Control Board, South end Conclave, Block 502, 5th and 6th Floors, 1582 Razidanga Main Road, Kolkata, West Bengal 700107.
2. The Member Secretary, State Pollution Control Board, A/118, Nilakantha Nagar, Bhubaneswar, Odisha-751012.
3. The Regional Officer, State Pollution Control Board, Baniapat, DD College Road, Keonjhar, Odisha-758001.

ENVIRONMENT CLEARANCE COMPLIANCE STATUS –NUAGAON MINE

Compliance report of Environmental Clearance for Nuagaon Iron Ore Mine, JSW Steel Ltd.

Reference letter from MoEF&CC, New Delhi- F. No. J-11015/1156/2007-IA.II (M) dated 05.08.2021.

Capacity- 7.99 MTPA Iron Ore (ROM)

Sl. No.	Environment Clearance Conditions	Self - Declaration	Compliance Remarks
A.	**Specific Conditions**		
1	The new lessee, after obtaining Letter of Intent (LoI), shall obtain approval under the FCA-1980 following due procedure, for non-forestry use of forest land falling in such mining lease for continuing mining operation beyond two years during which it has deemed to have acquired rights to undertake mining operation. In case, approval under the FCA-1980 is not obtained within the stipulated time of two years of commencement of lease by the new lessee, the mining operations shall be stopped till such approval has been obtained.	Being complied	LOI was issued to Nuagaon Iron Ore Mines of M/S JSW Steel Ltd vide letter no. 2291/S&M IV(Misc) SM-66/2016 dated 2nd March 2020 by Department of steel & Mines, Government of Odisha. The present mining operation is restricted within vested Forest area as per FC vide letter no F. No. 8-17/2001-FC, Dtd. 21/22.04.2004 over 476.205 ha. State Government (Steel & Mines Department) has given vested order in favour of M/s. JSW Steel Limited vide No. 4167/SM, dated 29.05.2020 FOR 2 years Further It got vested for 50 years vide letter no. 1303/ SM – MC1-MRL-0002-2020 dated 15.02.2022. FC transfer of 371.192 Ha has been taken from Govt of Odisha Forest, Environment & Climate Change department vide letter no. FE-DIV-FLD-0120-2021-7489/FE&CC dated 21.04.2022. LOI, Vesting Order copies and FC transfer letter has been attached as **Annexure I**
2	While obtaining approval under the provisions of FCA-1980 as per clause (b) above, the new lessee shall pay the Net Present Value (NPV) for the total forest area located within the mining lease, along with any other amount due as per guidelines issued by Government of India from time to time. However, on the date of issuance of LoI, the state government shall realize a lump sum amount at the rate of Rs 7.50 lakh per ha (for the total forest area within the mining lease) from the new LoI holder. This amount shall be deposited into the account of CAMPA, which will be adjusted against actual compensatory levies payable on the forest land, at the time of approval as per clause (b) above.	Complied	Advance NPV of Rs. 487131000 has already been deposited into the account of CAMPA with lump sum amount at the rate of Rs 7.50 lakh per ha (for the total forest area within the mining lease). Details has been attached as **ANNEXURE 1**
3	The budget of Rs. 1452.43 Lakhs to address the concerns raised by the public including in the public hearing to be completed within 3 years from the date of start of mining operations. PP shall comply all action plans made for public hearing concerns and make regular maintenance and record the progressive activity outcomes.	Being complied	Out of the total proposed budget of Rs. 1452.43 Lakhs, Nuagaon Iron Ore Mines of M/S JSW Steel ltd has done the expenditure of Rs 826 Lakhs., till 31.03.2023. Details for the same is attached as **Annexure II**
4	The Project Proponent shall undertake the adequate plantation in peripheral zone as well as gap plantation with the seeding of 6-8 ft height with at least 90% survival rate to control the dust at source and should be completed within 3 years from the date of commencement of mining operations. Causalities of the previous year should be replaced other than the saplings proposed to be planted every year.	Being complied	Gap Plantation has been carried out in safety zone, however 80% survival rate are being maintained, as well as causalities of the previous year are being replaced other than the saplings proposed to be planted every year. 2500 saplings were planted in FY 2021-22, and 6000 saplings were planted in FY 22-23 near MLP 96 – 101, MLP 32-35, MLP 26-28. 500 saplings were replaced against the casualties of the FY 2021-22 saplings. Photos for the same is attached as **Annexure III**
5	PP shall construct garland drains with protective bunds around excavated area, to avoid entrance of surface run off into pit and mixing with ground water. Furthermore, PP shall make garland drains/storm water drains along with siltation/settling tanks	Complied	Garland drains with protective bunds around excavated area has been constructed to avoid entrance of surface runoff into pit and mixing with ground water. Garland Drains have also been connected with settling pond in order to conserve the storm water. Around 4 Km Garland drains has been constructed and Photos for the same is attached as **Annexure IV**
6	Appropriate mitigative measures should be taken to prevent pollution of the Karo River and the SunaNadi in consultation with the State Pollution Control Board.	Complied	Check Dam along with series of 3 Settling Ponds of dimension 2m x 2m x 3m has been provided to prevent the pollution of Karo river, however there is no mining operation near Karo river. Mines lease is around 500m from Suna Nadi, no mining operations are being carried out near suna nadi. Photos of check dam is attached as **Annexure V**
7	The conservation plan in consultation with the Forest Department shall be implemented and compliance of the same shall be submitted to IRO of MOEF&CC before 1st July of every year.	Being Complied	Site Specific Wildlife Conservation plan got approved vide letter no: 1WL-C-FC-386/08. Dated 28.01.2009 by PCCF(Wildlife) and Chief Wild Life Warden. Approval Letter along with Implementation certificate has been attached as **Annexure VI**

8	Project proponent shall furnish a certificate from DFO regarding satisfactory compliance of site specific wildlife conservation plan prepared by earlier lessee.	Being complied	Implementation certificate vide file no. 3877/ 6F-Mining-33/2020 dated 05.07.2021 issued by DFO, Keonjhar has been attached as **Annexure VI**
9	No mining activities will be allowed in the part of forest land involved in the lease area i.e. 163.618 Ha (639.823 Ha- 476.205 Ha) for which the forest clearance is not available.	Agreed Upon	No mining activities are being carried out in the part of forest land involved in the lease area i.e. 163.618 Ha (639.823 Ha-476.205 Ha) for which the forest clearance is not available.
B.	**Recommendation of CSIR-NEERI Report on "Carrying Capacity Study for Environmentally Sustainable Iron and Manganese Ore Mining Activity in Keonjhar, Sundargarh and Mayurbhanj districts of Odisha State**		
1	Project Proponent and Department of Steel & wines, Govt. of Odisha shall ensure the implementation of recommendations of carrying capacity study report conducted by CSIR-NEERI w.r.t. mining proposal of iron Ore and/or manganese in the State of Odisha.	Complied	Recommendation of NEERI such as quantification of air emission load, mobile water sprinkler at haul road, dry fog type dust suppression system material handling plants (crusher and screen) to minimize air pollution has been implemented. Monitoring of ambient air and fugitive emission data has been implemented and report for the same is attached as Annexure VII. Ambient air quality is being monitored at buffer zone. CO is being measured as a parameter of ambient air quality. PUC check is being conducted for the vehicles. Noise level monitoring is being carried out. Flow rate measurement of perennial nala is being done. Oil and grease trap has been provided at the vehicle washing bay. Environmental sustainability report has also been attached with the NEERI report. 2 nos. of Mechanised wheel washing has been installed near exit and entry gate. Photos for the same is attached as **ANNEXURE VIII**
2	Department of Steel & Mines, Govt. of Odisha should prepare 5 years' regional plan for annual iron ore requirement from the state, which in turn shall be met from different mines/zones (e.g. Joda, Koira.) in the state. Accordingly, sustainable annual production (SAP) for each zone/mine may be followed adopting necessary environmental protection measures.	Agreed to comply	Department of Steel & Mines, Govt. of Odisha has prepared 5 years' regional plan for annual iron ore requirement from the state, which are being met from different mines/zones (e.g. Joda, Koira.) in the state. Accordingly, sustainable annual production (SAP) for each zone/mine are being followed. Report for the same is attached as **ANNEXURE IX**
3	Project Proponent shall construct the cement concrete road from mine entrance and exit to the main road with proper drainage system and green belt development along the roads and also construction of road with minimum 300 m inside the mine. This should be done within one year for existing mines and new mine should have since beginning. The Department of Steel & Mines, Govt. of Odisha should ensure the compliance and should not issue the Mining Permits, if mine lease holder has not constructed proper cement concrete road as suggested. This Environmental Clearance for the expansion project shall be operated only after the compliance of the above mentioned specific condition.	Complied	Cement concrete road from mine entrance and exit to the main road with proper drainage system and green belt development along the roads has been constructed. Along with this 300m of CC road has been provided from MDH weighbridge to Guali gate.
4	The Committee observed that as per the recommendations of NEERI report the PP needs to do regular vacuum cleaning of all mineral carrying roads aiming at "zero dust re-suspension" within 3 months. This Environmental Clearance for the expansion project shall be operated only after the compliance of the above mentioned specific condition.	Complied	One vacuum sweeping machine has been provided. Fixed water sprinkler of 5.6 Km has been provided in the haul road. Water sprinkling is being carried out along the haul road by two number of truck mounted tanker of reported capacity 50 Kl and 16 KL. Photos for the same is attached as **Annexure VIII**
5	Project Proponent shall monitor the environmental quality parameters as per EC and CTE/CTO conditions, and implementation of suggested measures for control of road dust and air pollution. Odisha State Pollution Control Board has to ensure the compliance of CTE/CTO. Regional office of the MoEF&CC, Bhubaneswar shall monitor the compliance of the EC conditions. Regional office of the Indian Bureau of Mines (IBM) shall monitor the compliance of mining plan and progressive mine closure plan. Any violation by mine lease holder may invite actions per the provisions of applicable Acts.	Complied	Environmental quality parameter such as ambient air quality, Fugitive emission, Noise level, Surface water quality, Ground water quality etc are being monitored by ECOMEN. Compliances are being monitored by IBM and MoEF&CC through various site visits and inspections. Report for the same has been attached as **Annexure VII**
6	Project Proponent shall ensure the compliance of Suggested Ore Transport Mode (SOTM) with association of the State Government of Odisha. All existing mines should ensure adoption of SOTM within next 5 years. New mines or mines seeking expansion should incorporate provision of SOTM in the beginning itself, and should have system in place within next 5 years.	Being Complied	Ore transportation through dumper truck are being carried out. 25 percent ore are being transported to railway siding (located at a distance of 10 km to 25 km approx.), 50 percent for shipping (located at a distance 300 km approx.) and to the end user (25% located at a distance of 200 km. approx.) by dumper.EC was accorded in the year 2021 and period of 5 year yet to be completed.

			In order to comply SOTM condition JSW has plan to lay 300 Km of slurry pipeline. Till now we have laid 60 km of slurry pipeline out of 300 Km from Nuagaon to Paradeep
7	The State Govt. of Odisha shall ensure dust free roads in mining areas wherever the road transportation of mineral is involved. The road shoulders shall be paved with fence besides compliance with IRC guidelines. All the roads should have proper drainage system and apart from paving of entire carriage width the remaining right of way should have native plantation (dust capturing species). Further, regular maintenance should also be ensured by the Govt. of Odisha. Progress on development of dust free roads, implementation of SOTM, increased use of existing rail network, development of additional railway network/conveyor belt/ pipelines etc. shall be submitted periodically to Regional office of the MoEF&CC.	Being Complied	Paved road has been provided for transportation of ore through the NH. Natural Plantation along the road has been carried out. 1 road sweeping along with dedicated 18 KL water tanker has been deployed for controlling the dust on the transportation road. SOTM will be implemented once EC for expansion gets approved. Till now we have laid 60 km of slurry pipeline out of 300 Km from Nuagaon to Paradeep.
8	Project Proponent shall develop the parking plazas for trucks with proper basic amenities/ facilities inside the mine. This should be done within one year for existing mines and new mines should have since beginning. This Environmental Clearance for the expansion project shall be operated only after the compliance of the above mentioned specific condition.	Complied	Parking plaza of capacity of 200 trucks has been developed at the site along with facilities such as toilet and rest area. Pavement of the parking plaza has also been done. Photos for the same is attached as **Annexure VIII**
9	Department of Steel & Mines shall ensure the construction of NH 215 as minimum 4 lane road with proper drainage system and plantation and subsequent regular maintenance of the road as per IRC guidelines. Construction of other mineral carrying roads with proper width and drainage system along with road side plantation to be carried out. This shall be completed within 2 Years.	Complied	4 lane road on NH 215 with proper drainage system and plantation has been constructed by State government and subsequent regular maintenance are being carried out.
10	Regular vacuum cleaning of all mineral carrying roads aiming at "Zero Dust Re- suspension" shall be adopted by PWD / NHAI/ Mine Lease Holders within a time Period of 3 months for existing roads. This Environmental Clearance for the expansion project shall be operated only after the compliance of the above mentioned specific condition.	Complied	One vacuum sweeping machine has been provided. 2 nos. Wheel washing has been provided at entry and exit gate of Guali and Katasahi. Fixed water sprinkler of 5.6 Km has been provided in part of the haul road. Water sprinkling is being carried out along the haul road by two number of truck mounted tanker of capacity 50Kl and 16 KL.
11	In case the total requirement of iron ore exceeds the suggested limit for that year, permission for annual production by an individual mine may be decided depending on approved EC capacity (for total actual dispatch) and actual production rate of individual mine during last year or any other criteria set by the State Govt., i.e. Dept. of Steel & Mines. Department of Steel and Mines in consultation with Indian Bureau of Mines-RO should prepare in advance mine-wise annual production scenario so that demand for iron ore can be anticipated, and actual production/dispatch does not exceed the suggested annual production.	Agreed Upon	Detail of production: for 2020-21 is Iron 4.214 MT, and for 2021-22 Iron 6.264 MT. EC accorded for 7.99 MTPA(ROM) of iron ore along with 2.MTPA beneficiation plant
12	R&D studies towards utilization of low-grade iron ore should be conducted through research/academic institutes like IMMT, Bhubaneswar, NML, Jamshedpur, and concerned metallurgical departments in IITs, NITs etc., targeting full utilization of low-grade iron ore (Fe content up to 45% by 2020 and up to 40% by 2025). In fact, life cycle assessment of whole process including environmental considerations should be done for techno-economic and environmental viability. R&D studies on utilization of mine wastewater having high concentration of Fe content for different commercial applications in industries such as cosmetics, pharmaceutical, paint industry should also be explored. Responsibility: IBM, Dept. of Steel & Mines, Individual Mine Lease Holders.	Complied	Report on washing and de-sliming of iron ore fines of Nuagaon mines prepared by IMMT Bhubaneswar has been carried out and is attached as **Annexure X.**
13	The mining activity in Joda-Koira sector is expected to continue for another 100 years, therefore, it will be desirable to develop proper rail network in the region. Rail transport shall not only be pollution free mode but also will be much economical option for iron ore transport. The rail network and/or conveyor belt system up to public railway siding	Being Complied	Ore transportation through dumper truck are being carried out. 25 percent ore are being transported to railway siding (located at a distance of 10 km to 25 km approx.), 50 percent for shipping (located at a distance 300 km approx.) and to the end user (25% located at a distance of 200 km. approx.) by dumper.EC was accorded in the year 2021.

	needs to be created. The total length of the conveyor belt system/ rail network to be developed from mines to nearest railway sidings by 11 mines in Joda region is estimated to be about 64 km. Similarly, in Koira region, total length of rail network/ conveyor system for 8 mines (under SOTM 1 & 2) is estimated to be around 95 km. Further, it is suggested to develop a rail network connecting Banspani (Joda region) and Roxy railway sidings in Koira region. Responsibility: Dept. of Steel & Mines, Govt. of Odisha and Concerned Mines along with Indian Railways. Time Period: Maximum 7 years (by 2025). The Department of Steel & Mines, Govt. of Odisha should follow-up with the concerned Departments and railways so that proposed proper rail network is in place by 2025.		
14	State Govt. of Odisha shall make all efforts to ensure exhausting all the iron & manganese ore resources in the existing working mines and from disturbed mining leases/zones in Joda and Koira region. The criteria suggested shall be applicable while suggesting appropriate lease area and sustainable mining rate. Responsibility: Dept. of Steel & Mines, Govt. of Odisha.	Agreed upon	We ensure to exhaust all the Iron ore resources in the site.
15	Mining Operations/Process Related: Project Proponent shall implement the following mitigation measures: (i) Appropriate mining process and machinery (viz. right capacity, fuel efficient) should be selected to carry out various mining operations that generate minimal dust/air pollution, noise, wastewater and solid waste. e.g. drills should either be operated with dust extractors or equipped with water injection system. (ii) After commencement of mining operation, a study should be conducted to assess and quantify emission load generation (in terms of air pollution, noise, waste water and solid waste) from each of the mining activity (including transportation) on annual basis. Efforts should be made to further eliminate/ minimize generation of air pollution/dust, noise, wastewater, solid waste generation in successive years through use of better technology. This shall be ensured by the respective mine lease holders. (iii) Various machineries/equipment selected (viz. dumpers, excavators, crushers, screen plants etc.) and transport means should have optimum fuel/power consumption, and their fuel/power consumption should be recorded on monthly basis. Further, inspection and maintenance of all the machineries/ equipment/ transport vehicles should be followed as per manufacturer's instructions/ recommended time schedule and record should be maintained by the respective mine lease holders. (iv) Digital processing of the entire lease area using remote sensing technique should be carried out regularly once in 3 years for monitoring land use pattern and mining activity taken place. Further, the extent of pit area excavated should also be demarcated based on remote sensing analysis. This should be done by ORSAC (Odisha Space Applications Centre, Bhubaneswar) or an agency of national repute or if done by a private agency, the report shall be vetted/ authenticated by ORSAC, Bhubaneswar. Expenses towards the same shall be borne by the respective mine lease holders. Responsibility: Individual Mine Lease Holders.	Complied	Drilling is equipped with wet drilling along with dust extractor. Dust load calculation has been carried out and report is attached with NEERI compliance report as ANNEXURE XI. Inspection and maintenance of all the machineries/ equipment/ transport vehicles are being followed as per manufacturer's instructions/ recommended time schedule and records are being maintained. Dept. PUC check for vehicles are being carried out annually. Land use land cover map based on drone image certified by ORSAC is attached as **<u>ANNEXURE XII.</u>**
16	**Air Environment Related**: Project Proponent shall implement the following mitigation measures: (i) Fugitive dust emissions from all the sources should be controlled regularly on daily basis. Water spraying arrangement on haul roads, loading and unloading and at other transfer points should be provided and properly maintained. Further, it will be desirable to use water fogging system to minimize water consumption. It should be ensured that the ambient air quality parameters conform to	Complied	Fugitive emission monitoring is being carried out at 6 different locations i.e. Screen Plant, waste dump, mines face bench, Crusher plant, loading point and Mines haulage road. Fixed water spraying arrangement of around 2.4 Km has been provided, water tanker two no to suppress dust at the haul road has also been provided. Ambient air quality monitoring are being carried out at four different locations for PM10, PM2.5, SO2, NO2 and CO.. Three online ambient air quality monitoring station has been installed for monitoring of PM10, PM2.5, SO2, NO2 and CO.

	the norms prescribed by the CPCB in this regard. (ii) The core zone of mining activity should be monitored on daily basis. Minimum four ambient air quality monitoring stations should be established in the core zone for SPM, PM10, PM2.5, SO2, NOx and CO monitoring. Location of air quality monitoring stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets and frequency of monitoring should be undertaken in consultation with the State Pollution Control Board (based on Emission Load Assessment Study). The number of monitoring locations may be more for larger capacity mines and working in larger area. Out of four stations, one should be online monitoring station in the mines having more than 3 MTPA EC Capacity. (iii) Monitoring in buffer zone should be carried out by SPCB or through NABET accredited agency. In addition, air quality parameters (SPM, PM10, PM2. 5, 5O2, NOx and CO) shall be regularly monitored at locations of nearest human habitation including schools and other public amenities located nearest to source of the dust generation as applicable. (iv) Emissions from vehicles as well as heavy machinery should be kept under control and regularly monitored. Measures should be taken for regular maintenance of vehicles used in mining operations and in transportation of mineral. (v) The vehicles shall be covered with a tarpaulin and should not be overloaded. Further, possibility of closed container trucks should be explored for direct to destination movement of iron ore. Air quality monitoring at one location should also be carried out along the transport route within the mine (periodically, near truck entry and exit gate), Responsibility: Individual Mine Lease Holders and SPCB		PP furnished manual monitoring data of four locations. Report for the same is attached as ANNEXURE VII Monitoring at buffer zone in four location i.e Koira Basti, Bhanjpali village, Kashira Basti and Segasagi village for PM10, PM2.5, SO2, NO2 and CO are being carried out. PUC check are being carried out and transportation is being done through covered trucks, along with this overloading are being rectified by automated weighbridges. Photos of covered trucks is attached as **ANNEXURE XIII.**
17	**Noise and Vibration Related**: Project Proponent shall implement the following mitigation measures: (i) Blasting operation should be carried out only during daytime. Controlled blasting such as Nonel, should be practiced. The mitigation measures for control of ground vibrations and to arrest fly rocks and boulders should be implemented. (ii) Appropriate measures should be taken for control of noise levels below 85 DB in the work environment. Workers engaged in operations of HEMM, etc. should be provided with ear plugs/muffs. (iii) Noise levels should be monitored regularly (on weekly basis) near the major sources of noise generation within the core zone. Further, date, time and distance of measurement should also be indicated with the noise levels in the report. The data should be used to map the noise generation from different activities and efforts should be made to maintain the noise levels with the acceptable limits of CPCB (CPCB, 2000) (iv) Similarly, vibration at various sensitive locations should be monitored at least once in month, and mapped for any significant changes due to successive mining operations. Responsibility: Individual Mine Lease Holders.	Complied	Blasting operation are being carried out on day time only and controlled blasting is being practiced by using nonel. However, blasting study are being carried out monthly. Blasting report along with mapping of the significant changes or variation in ppv graph is attached as ANNEXURE XIV Ambient Noise level monitoring are being carried out at 4 different locations in core zone as well as 4 locations in buffer zone. Along with this Source noise monitoring are carried out at 15 different locations. and Noise monitoring report along with mapping of the significant changes is attached as **ANNEXURE XV**
18	**Water/Wastewater Related**: Project Proponent shall implement the following mitigation measures: (i) In general, the mining operations should be restricted to above ground water table and it should not intersect groundwater table. However, if enough resources are estimated below the ground water table, the same may be explored after conducting detailed geological studies by GSI and hydro-geological studies by CGWB or NIH or institute of national repute, and ensuring that no damage to the land stability/ water aquifer system shall happen. The details/ outcome of such study may be reflected/incorporated in the EIA/EMP report of the mine appropriately. (ii) Natural watercourse and/or water resources should not be obstructed due to any mining operations. Regular monitoring of the flow	Complied	The ground water table has not been intersected. There is no Obstruction to natural water course. Monitoring of Surface water flow rate and quality of upstream and downstream of Topadihi nala, Karo nala, Teheri nalaand Kakara pani nala is being done. Ground water level and quality monitoring data are also being carried out. ETP of 15 KL with oil and grease trap system and STP of 30 KL has been installed at workshop area and Operator colony respectively. Garland drain of 4 Km has been constructed all along the haul road and 400m along the Katesahi OB dump. Retaining wall of 500m has been provided around the OB dump. Along with this dry stone wall of 800 m has been constructed around the S.G dumps. Series of settling ponds has been constructed for runoff management.

	rate of the springs and perennial nallas should be carried out and records should be maintained. Further, regular monitoring of water quality of nallas and river passing thorough the mine lease area (upstream and downstream locations) should be carried out on monthly basis. (iii) Regular monitoring of ground water level and its quality should be carried out within the mine lease area by establishing a network of existing wells and constructing new piezometers during the mining operation. The monitoring should be carried out on monthly basis. (iv) In order to optimize water requirement, suitable conservation measures to augment ground water resources in the area should be undertaken in consultation with Central Ground Water Board (CGWB). (v) Suitable rainwater harvesting measures on long term basis should be planned and implemented in consultation with CGWB, to recharge the ground water source. Further, CGWB can prepare a comprehensive plan for the whole region. (vi) Appropriate mitigation measures (viz. ETP, STP, garland drains, retaining walls, collection of runoff etc.) should be taken to prevent pollution of nearby river/other water bodies. Water quality monitoring study should be conducted by State Pollution Control Board to ensure quality of surface and ground water sources on regular basis. The study can be conducted through NABL/ NABET approved water testing laboratory. However, the report should be vetted by SPCB. (vii) Industrial wastewater (workshop and wastewater from the mine) should be properly collected, treated in ETP so as to conform to the discharge standards applicable. (viii) Oil and grease trap should be installed before discharge of workshop effluents. Further, sewage treatment plant should be installed for the employees/colony, wherever applicable. (ix) Mine lease holder should ensure that no silt originating due to mining activity is transported in the surface water course or any other water body. Appropriate measures for prevention and control of soil erosion and management of silt should be undertaken. Quantity of silt/soil generated should be measured on regular basis for its better utilization. (x) Erosion from dumps site should be protected by providing geo-textile matting or other suitable material, and thick plantation of native trees and shrubs should be carried out at the dump slopes. Further, dumps should be protected by retaining walls. (xi) Trenches/ garland drain should be constructed at the foot of dumps to arrest silt from being carried to water bodies. Adequate number of check dams should be constructed across seasonal/perennial nallas (if any) flowing through the mine lease areas and silt be arrested. De-silting at regular intervals should be carried out and quantity should be recorded for its better utilization, after proper soil quality analysis. (xii) The water so collected in the reservoir within the mine should be utilized for the sprinkling on hauls roads, green belt development etc. (xiii) There should be zero waste water discharge from the mine. Based on actual water withdrawal and consumption/ utilization in different activities, water balance diagram should be prepared on monthly basis, and efforts should be made to optimize consumption of water per ton of ore production in successive years. Responsibility: Individual Mine Lease Holders, SPCB and CGWB.		Around 11 settling ponds of different dimensions has been constructed within the mine lease area. Rain water harvesting structure of dimension 50m x 20m x 6m has been constructed near Kanusahi area. Photos of garland drain, settling pond **ANNEXURE IV** and rain water harvesting structure is attached as **ANNEXURE XVI.** Coir mat of around 1000 sqm has been installed in some part of SG dump. OB dump at katasahi is in active stage, once it gets stabilized proper stabilization will be done.
19	**Land/Soil/Overburden Related**: Project Proponent shall implement the following mitigation measures: (i) The top soil should temporarily be stored at earmarked site(s) only and it should not be kept unutilized for long (not more than 3 years or as per provisions mentioned in the mine plan/ scheme). The topsoil should be used for land reclamation and plantation appropriately. (ii) Fodder plots should be developed in the non-	Complied	There is no Top soil dump within the mine lease area, once it generated it will be stored at earmarked location. There is no use of grazing land. Over burden, low grade ore stacked in the earmarked area. Slope stability study has been conducted through NIT Rourkela. Height of the OB dump is 63m , slope is 23^0 and width is 98m.

	mineralised area in lieu of use of grazing land, if any. (iii) Over burden/ low grade ore should be stacked at earmarked dump site (s) only and should not be kept active for long period. The dump height should be decided on case to case basis, depending on the size of mine and quantity of waste material generated. However, slope stability study should be conducted for larger heights, as per IBM approved mine plan and DGMS guidelines. The OB dump should be scientifically vegetated with suitable native species to prevent erosion and surface run off. In critical areas, use of geo textiles should be undertaken for stabilization of the dump. Monitoring and management of rehabilitated areas should continue until the vegetation becomes self-sustaining. Proper records should be maintained regarding species, their growth, area coverage etc. (iv) Catch drains and siltation ponds of appropriate size should be constructed to arrest silt and sediment flows from mine operation, soil, OB and mineral dumps. The water so collected can be utilized for watering the mine area, roads, green belt development etc. The drains should be regularly de-silted, particularly after monsoon and should be maintained properly. Appropriate documents should be maintained. Garland drain of appropriate size, gradient and length should be constructed for mine pit, soil. OB and mineral dumps and sump capacity should be designed with appropriate safety margin based on long term rainfall data. Sump capacity should be provided for adequate retention period to allow proper settling of silt material. Sedimentation pits should be constructed at the corners of the garland drains and de-silted at regular intervals. (v) Backfilling should be done as per approved mining plan/scheme. There should be no OB dumps outside the mine lease area. The backfilled area should be afforested, aiming to restore the normal ground level. Monitoring and management of rehabilitated areas should continue till the vegetation is established and becomes self-generating. (vi) Hazardous waste such as, waste oil, lubricants, resin, and coal tar etc. should be disposed off as per provisions of Hazardous Waste Management Rules, 2016, as amended from time to time. Responsibility: Individual Mine Lease Holders.		Garland drain of 4 Km has been constructed all along the haul road and 400m along the Ktesahi OB dump. Retaining wall of 500m has been provided around the OB dump. Along with this dry masonary wall of 400 m has been constructed around the S.G dump of ex-lessee. Series of settling ponds has been constructed for runoff management. Around 11 settling ponds of different dimensions has been constructed within the mine lease area. Rain water harvesting structure of dimension 50m x 20m x 6m has been constructed near Kanusahi area. Backfilling has not been carried out. Hazardous waste authorization was granted vide authorization number IND-IV-HW-1348/5322 dated 31-03-2022 for waste oil, lubricants, etc. which are being disposed of through authorized recycler. Renewal application has been applied vide application no. 4562912 dated 26.12.2022. Form III, IV, HWA and manifesto has been attached as **ANNEXURE XVII.**
20	**Ecology/Biodiversity (Flora-Fauna) Related**: Project Proponent shall implement the following mitigation measures: (i) All precautionary measures should be taken during mining operation for conservation and protection of endangered fauna namely elephant, sloth bear etc. spotted in the study area. Action plan for conservation of flora and fauna should be prepared and implemented in consultation with the State Forest and Wildlife Department within the mine lease area, whereas outside the mine lease area, the same should be maintained by State Forest Department. (ii) Afforestation is to be done by using local and mixed species saplings within and outside the mining lease area. The reclamation and afforestation is to be done in such a manner like exploring the growth of fruit bearing trees which will attract the fauna and thus maintaining the biodiversity of the area. As afforestation done so far is very less, forest department needs to identify adequate land and do afforestation by involving local people in a time bound manner. (iii) Green belt development carried out by mines should be monitored regularly in every season and parameters like area under vegetation/plantation, type of plantation, type of tree species /grass species/scrubs etc., distance between the plants and survival rate should be recorded. (iv) Green belt is an important sink of air pollutants including noise. Development of green cover in mining area will not only help reducing air and noise pollution but also will improve the	Complied	Site Specific Wildlife Conservation plan got approved vide letter no: 1WL-C-FC-386/08. Dated 28.01.2009 by PCCF(Wildlife) and Chief Wild Life Warden. Afforestation has been carried out by using local and mixed species saplings. Fruit bearing plants has been planted within the mine lease area. Greenbelt development has been carried out. Gap Plantation has been carried out in safety zone, however 80% survival rate are being maintained, as well as causalities of the previous year are being replaced other than the saplings proposed to be planted every year. 2500 saplings were planted in FY 2021-22, and 6000 saplings were planted in FY 22-23. 500 saplings were replaced against the casualties of the FY 2021-22 saplings.

	ecological conditions and prevent soil erosion to a greater extent. Further, selection of tree species for green belt should constitute dust removal/dust capturing plants since plants can act as efficient biological filters removing significant amounts of particulate pollution. Thus, the identified native trees in the mine area may be encouraged for plantation. Tree species having small leaf area, dense hair on leaf surface (rough surface), deep channels on leaves should be included for plantation. (v) Vetiver plantation on inactive dumps may be encouraged as the grass species has high strength of anchoring besides medicinal value. (vi) Details of compensatory afforestation done should be recorded and documented by respective forest divisions, and State Forest Department should present mine-wise annual status, along with expenditure details. Responsibility: Individual Mine Lease Holders and State Forest & Wildlife Department.		
21	**Socio-Economic Related**: Project Proponent shall implement the following mitigation measures: (i) Public interaction should be done on regular basis and social welfare activities should be done to meet the requirements of the local communities. Further, basic amenities and infrastructure facilities like education, medical, roads, safe drinking water, sanitation, employment, skill development, training institute etc. should be developed to alleviate the quality of life of the people of the region. (ii) Land outees and land losers/affected people, if any, should be compensated and rehabilitated as per the national/state policy on Resettlement and Rehabilitation. (iii) The socio-economic development in the region should be focused and aligned with the guidelines/initiatives of Govt. of India/ NITI Aayog around prosperity, equality, justice, cleanliness, transparency, employment, respect to women, hope etc. This can be achieved by providing adequate and quality facilities for education, medical and developing skills in the people of the region. District administration in association with mine lease holders should plan for "Samagra Vikas" of these blocks well as other blocks of the district. While planning for different schemes in the region, the activities should be prioritized as per Pradhan Mantri Khanij Kshetra Kalyan Yojna (PMKKKY), notified by Ministry of Mines, Govt. of India, vide letter no. 16/7/2017-M.VI (Part), dated September 16, 2015. Responsibility: District Administration and Individual Mine Lease Holders.	Being complied	Public interactions are being carried out on regular basis and social welfare activities are being done to meet the requirements of the local communities Activities like education, medical, roads, safe drinking water, sanitation, employment, skill development, training institute etc. has been developed to alleviate the quality of life of the people. Details of social development activities along with photos has been attached as **ANNEXURE XVIII.**
22	**Road Transport Related**: Project Proponent shall implement the following mitigation measures: (i) All the mine lease holders should follow the suggested ore transport mode (SOTM), based on its EC capacity within next 5 years. (ii) The mine lease holders should ensure construction of cement road of appropriate width from and to the entry and exit gate of the mine. Further, maintenance of all the roads should be carried out as per the requirement to ensure dust free road transport. (iii) Transportation of ore should be done by covering the trucks with tarpaulin or other suitable mechanism so that no spillage of ore/dust takes place. Further, air quality in terms of dust, PM:t0 should be monitored near the roads towards entry & exit gate on regular basis, and be maintained within the acceptable limits. Responsibility: Individual Mine Lease Holders and Dept. of Steel & Mines.	Complied	Cement road has been constructed at the entry gate. Road sweeping machine has been provided to ensure dust free road transport. Transportation of ore are being carried out through covered truck. Air quality has been monitored near Katasahi gate.
23	**Occupational Health Related**: Project Proponent shall implement the following mitigation measures: (i) Personnel working in dusty areas should wear protective respiratory devices and they should also be provided with adequate training and information on safety and health aspects periodically. (ii) Occupational health surveillance program for all the employees/workers (including casual workers)	Complied	Total 800 numbers of PPEs like safety shoes, reflective jacket, safety glass, ear plugs, helmets etc. have been distributed. Personnel working in dusty areas wear protective respiratory devices and vocational training and information on safety and health aspects are being given to them periodically. Total number of 3008 Vocational trainings has been carried out.

	should be undertaken periodically (on annual basis) to observe any changes due to exposure to dust, and corrective measures should be taken immediately, if needed. (iii) Occupational health and safety measures related awareness programs including identification of work related health hazard, training on malaria eradication, HIV and health effects on exposure to mineral dust etc., should be carried out for all the workers on regular basis. A full time qualified doctor should be engaged for the purpose. Periodic monitoring (on 6 monthly basis) for exposure to respirable minerals dust on the workers should be conducted, and record should be maintained including health record of all the workers. Review of impact of various health measures undertaken (at an interval of 3 years or less) should be conducted followed by follow-up of actions, wherever required. Occupational health centre should be established near mine site itself. Responsibility: Individual Mine Lease Holders and District Administration (District Medical Officer).		773.numbers of IME has been conducted for Nuagaon Iron Ore mines. Photos of the training and IME form O are attached as **ANNEXURE XIX**. Occupational health and safety measures related awareness programs including identification of work related health hazard, training on malaria eradication, HIV and health effects on exposure to mineral dust etc., are being carried out. Photos for the same is attached as **Annexure XIX**
C.	**Standard Conditions**		
I.	**Statutory Compliance**		
1	This Environmental Clearance (EC) is subject to orders/ judgment of Hon'ble Supreme Court of India, Hon'ble High Court, Hon'ble NGT and any other Court of Law, Common Cause Conditions as may be applicable.	Agreed to comply	Agree to abide by the condition
2	The Project proponent complies with all the statutory requirements and judgment of Hon'ble Supreme Court dated 2nd August,2017 in Writ Petition (Civil) No. 114 of 2014 in matter of Common Cause versus Union of India & Ors. before commencing the mining operations.	Agreed to comply	Agree to abide by the condition
3	The State Government concerned shall ensure that mining operation shall not be commenced till the entire compensation levied, if any, for illegal mining paid by the Project Proponent through their respective Department of Mining & Geology in strict compliance of Judgment of Hon'ble Supreme Court dated 2nd August, 2017 in Writ Petition (Civil} No. 114 of 2014 in matter of Common Cause versus Union of India & Ors.	Being complied	State Government (Steel & Mines Department) has given vested order in favour of M/s. JSW Steel Limited vide No. 4167/SM, dated 29.05.2020 FOR 2 years Further It got vested for 50 years vide letter no. 1303/ SM – MC1-MRL-0002-2020 dated 15.02.2022 for grant of mining lease for 50 years and all clearances, vested under section-8A, Sub section-2 of Mines and Mineral Development Regulation Act, 1957.
4	The Project Proponent shall follow the mitigation measures provided in MoEFCC's Office Memorandum No. Z-11013/57/2014-IA.II (M), dated 29th October, 2014, titled "Impact of mining activities on Habitations-Issues related to the mining Projects wherein Habitations and villages are the part of mine lease areas or Habitations and villages are surrounded by the mine lease area".	Complied	As per the Office Memorandum No. Z-11013/57/2014-IA.II (M), dated 29th October, 2014, titled "Impact of mining activities on Habitations-Issues of MoEFCC's, mitigative measures are being taken care of. This includes construction of garland drains, check dams, retaining walls and settling ponds. OM also states about the regular monitoring of natural stream, illumination survey and others which are being carried out.
5	A copy of EC letter will be marked to concerned Panchayat / local NGO etc. if any, from whom suggestion / representation has been received while processing the proposal.	Complied	A copy of EC letter was marked to the sarpanch of Loidapada vide letter no. JSW/S/O/2021/194 dated 18/08/2021. Copy of the same is attached as **Annexure XX**
6	State Pollution Control Board/Committee shall be responsible for display of this EC letter at its Regional office, District Industries Centre and Collector's office/ Tehsildar's Office for 30 days.	Complied	State Pollution Control Board/Committee has displayed EC letter at its Regional office, District Industries Centre and Collector's office/ Tehsildar's Office
7	The Project Authorities should widely advertise about the grant of this EC letter by printing the same in at least two local newspapers, one of which shall be in vernacular language of the concerned area. The advertisement shall be done within 7 days of the issue of the clearance letter mentioning that the instant project has been accorded EC and copy of the EC letter is available with the State Pollution Control Board/Committee and web site of the Ministry of Environment, Forest and Climate Change (www.parivesh.nic.in). A copy of the advertisement may be forwarded to the concerned MoEFCC Regional Office for compliance and record.	Complied	Nuagaon Iron Ore Mine Environment Clearance advertisement publication in two local newspapers i.e. "The New Indian Express" dated 10.08.2021 and "The Samaja" dated 11.08.2021 (vernacular language). Copies of the newspaper publications are submitted to ERO MOEF&CC vide letter No. JSW/S/O/2021/185 Date: 11/08/2021. Copy is attached as **ANNEXURE XXI**
8	The Project Proponent shall inform the MoEF&CC for any change in ownership of the mining lease. In case there is any change in ownership or mining	Agreed to comply	TOR for expansion from 5.62 to 7.99 MTPA was accorded to ex-lessee KJS Ahluwalia, while EC was accorded to JSW Steel Ltd, PP will inform the MoEF&CC for any change in

	lease is transferred than mining operation shall only be carried out after transfer of EC as per provisions of the para 1I of EIA Notification, 2006 as amended from time to time		ownership of the mining lease. In case there is any change in ownership or mining lease is transferred than mining operation will only be carried out after transfer of EC as per provisions of the para 1I of EIA Notification, 2006. No change in ownership of the mining lease.
II	**Air quality monitoring and preservation**		
9	The Project Proponent shall install a minimum of 3 (three) online Ambient Air Quality Monitoring Stations with 1 (one) in upwind and 2 (two) in downwind direction based on long term climatological data about wind direction such that an angle of 120° is made between the monitoring locations to monitor critical parameters, relevant for mining operations, of air pollution viz. PM10, PM2.5, NO2, CO and SO2 etc. as per the methodology mentioned in NAAQS Notification No. B-29016/2o/go/PCI/I, dated 18.11.2009 covering the aspects of transportation and use of heavy machinery in the impact zone. The ambient air quality shall also be monitored at prominent places like office building, canteen etc. as per the site condition to ascertain the exposure characteristics at specific places. The above data shall be digitally displayed within 03 months in front of the main Gate of the mine site.	Complied	In consultation with SPCB, three numbers of Continuous ambient air monitoring stations (CAAQMS) has been installed for PM10, PM2.5, NO2, CO and SO2, maintaining an angle of 120^0 Location are as below- CAAQMS 1. Nuagaon_Mines Office CAAQMS 2. Nuagaon_Pilar 99 CAAQMS 3. Nuagaon_Dispensary Digital Display Board- Near MDH Gate area . Photos for the same is attached as **Annexure XXII**
10	Effective safeguard measures for prevention of dust generation and subsequent suppression (like regular water sprinkling, metalled road construction etc.) shall be carried out in areas prone to air pollution wherein high levels of PM10 and PM2.5 are evident such as haul road, loading and unloading point and transfer points. The Fugitive dust emissions from all sources shall be regularly controlled by installation of required equipment's/ machineries and preventive maintenance. Use of suitable water-soluble chemical dust suppressing agents may be explored for better effectiveness of dust control system. It shall be ensured that air pollution level conform to the standards prescribed by the MoEFCC/ Central Pollution Control Board.	Complied	Fugitive emission monitoring is being carried out at 6 different locations i.e. Screen Plant, waste dump, mines face bench, Crusher plant, loading point and Mines haulage road. Fixed water spraying arrangement of around 5.6 Km has been provided, water tanker two no to suppress dust at the haul road has also been provided. Regular water sprinkling through mobile water sprinkler tankers being carried out on haul roads with dedicated 50 KL and 16 KL. Water soluble chemicals after addition with the water tankers are also being used on the haul roads. Photos of chemicals used on the haul road is attached as **ANNEXURE XXIII**
III	**Water quality monitoring and preservation**		
11	In case, immediate mining scheme envisages intersection of ground water table, then Environmental Clearance shall become operational only after receiving formal clearance from CGWA. In case, mining operation involves intersection of ground water table at a later stage, then PP shall ensure that prior approval from CGWA and MoEFCC is in place before such mining operations. The permission for intersection of ground water table shall essentially be based on detailed hydro-geological study of the area.	Being complied	NOC from CGWA for 1225 m3/day is already vested to JSW for 2 years and has been transferred in the name of JSW vide application No. 21-4(92)/SER/CGWA/2008/831 dated 3rd Nov. 2017. Similarly, JSW has applied for NOC renewal, which has been approved in the 24th internal EAC meeting. Ground water NOC with approved letter is attached as **ANNEXURE XXIV**
12	Project Proponent shall regularly monitor and maintain records w.r.t. ground water level and quality in and around the mine lease by establishing a network of existing wells as well as new piezo-meter installations during the mining operation in consultation with Central Ground Water Authority/ State Ground Water Department. The Report on changes in Ground water level and quality shall be submitted on six-monthly basis to the Regional Office of the Ministry, CGWA and State Groundwater Department / State Pollution Control Board.	Complied	Monitoring of Surface water flow rate and quality of upstream and downstream of Topadihi nala, Karo nala, Teheri nalaand Kakara pani nala is being done.. Ground water level and quality monitoring data are also being carried out
13	The Project Proponent shall undertake regular monitoring of natural water course/ water resources/ springs and perennial nallahs existing/ flowing in and around the mine lease and maintain its records. The project proponent shall undertake regular monitoring of water quality upstream and downstream of water bodies passing within and nearby/ adjacent to the mine lease and maintain its records. Sufficient number of gullies shall be provided at appropriate places within the lease for management of water. PP shall Carryout regular monitoring w.r.t. pH and included the same in monitoring plan. The parameters to be monitored	Complied	Regular monitoring of water quality of upstream and downstream being carried out and Monitoring Reports are attached as **Annexure VII** by ECOMEN. Flow rate of the nearby nallas and river are being measured. No natural watercourse and water resources are obstructed due to mining operations & the same will be taken care of. Existing check dams being maintained to prevent any pollution of the nearby water bodies. 2 piezometers has been installed within the mines lease area in consultation with CGWA, data for the same is attached as **ANNEXURE XXV**.

	shall include their water quality vis-à-vis suitability for usage as per CPCB criteria and flow rate. It shall be ensured that no obstruction and/or alteration be made to water bodies during mining operations without justification and prior approval of MoEFCC. The monitoring of water courses/ bodies existing in lease area shall be carried out four times in a Year viz. pre- monsoon (April-May). monsoon (August), post-monsoon (November) and winter (3anuary) and the record of monitored data may be sent regularly to Ministry of Environment, Forest and Climate Change and its Regional Office, Central Ground Water Authority and Regional Director, Central Ground Water Board, State Pollution Control Board and Central Pollution Control Board. Clearly showing the trend analysis on six-monthly basis.		
14	Quality of polluted water generated from mining operations which include Chemical Oxygen Demand (COD) in mines run-off; acid mine drainage and metal contamination in runoff shall be monitored along with Total Suspended Solids (TDS), Dissolved Oxygen (DO), pH and Total Suspended Solids (TSS). The monitored data shall be uploaded on the website of the company as well as displayed at the project site in public domain, on a display board, at a suitable location near the main gate of the Company. The circular No. J-20012/1/2006- IA.II (M) dated 27.05.2009 issued by Ministry of Environment, Forest and Climate Change may also be referred in this regard.	Complied	Display board has been provided near the gate. Monitored data uploaded in the website of the company along with six monthly compliances of Apr22 to Sep 22. No polluted water generated from the Mine. Link of the company website is mentioned below. **https://www.jswsteel.in/investors/jsw-steel-investor-information-environmental-clearances**
15	Project Proponent shall plan, develop and implement rainwater harvesting measures on long term basis to augment ground water resources in the area in consultation with Central Ground Water Board/ State Groundwater Department. A report on amount of water recharged needs to be submitted to Regional Office MoEFCC annually.	Complied	Mine sump of dimension (150x50x7) has been used as rain water harvesting measure. Rain water harvesting structure of dimension 50m x 20m x 6m has also been constructed near Kanusahi area. Hydrology study carried out by accredited agency as per CGWB guideline.
16	Industrial waste water (workshop and waste water from the mine) should be properly collected and treated so as to conform to the notified standards prescribed from time to time. The standards shall be prescribed through Consent to Operate (CTO) issued by concerned State Pollution Control Board (SPCB). The workshop effluent shall be treated after its initial passage through Oil and grease trap.	Complied	Workshop along with ETP/Oil Grease Trap System developed in the mine. No process water being discharged from the mine. The waste water generated from workshop being treated by ETP/Mechanized Oil Grease Trap System with recirculation facility. Regular Monitoring of water quality parameters being carried out by NABET Accredited laboratory. Report for the same is attached as **ANNEXURE VII**
17	The water balance/water auditing shall be carried out and measure for reducing the consumption of water shall be taken up and reported to the Regional Office of the MoEF&CC and State Pollution Control Board/ Committee.	Complied	Total water requirement for Nuagaon Iron Ore mines is 1225 KLD. Rain water collected in pits are being utilizing for dust suppression in the mining operations. Fixed water sprinklers, pressurized mobile water tankers get utilized for dust suppression arrangement for reducing water requirement. Complete water balance diagram is attached as **ANNEXURE XXVI**
IV	**Noise and vibration monitoring and prevention**		
18	The peak particle velocity at 500m distance or within the nearest habitation, whichever is closer shall be monitored periodically as per applicable DGMS guidelines.	Complied	Peak particle velocity are being monitored at 500m distance.
19	The illumination and sound at night at project sites disturb the villages in respect of both human and animal population. Consequent sleeping disorders and stress may affect the health in the villages located close to mining operations. Habitations have a right for darkness and minimal noise levels at night. PPs must ensure that the biological clock of the villages is not disturbed; by orienting the floodlights/ masks away from the villagers and keeping the noise levels well within the prescribed limits for day /night hours.	Complied	Mining is being carried out in the already broken up area as per approved mine plan. Illumination and sound is restricted into core zone only. No project sites disturb the villages in respect of both human and animal population. Ambient Noise level monitoring are being carried out at 4 different locations in core zone as well as 4 locations in buffer zone. Along with this Source noise monitoring are carried out at 15 different locations. and Noise monitoring report along with mapping of the significant changes is attached as **ANNEXURE XV**
20	The Project Proponent shall take measures for control of noise levels below 85 dBA in the work environment. The workers engaged in operations of HEMM, etc. should be provided with ear plugs /muffs. All personnel including labourers working in dusty areas shall be provided with protective respiratory devices along with adequate training,	Complied	As per the observation from noise monitoring regularly carried out, noise level is observed to be below 85dBA in the work zone area. 800 no PPE set (including helmet, safety shoe, safety jacket, ear muffs, and dust musk) has been issued. Workers are equipped with PPEs in the working zone.

	awareness and information on safety and health aspects. The PP shall be held responsible in case it has been found that workers/ personals/ labourers are working without personal protective equipment.		
V	**Mining Plan**		
21	The Project Proponent shall adhere to approved mining plan, inter alia, including, total excavation (quantum of mineral, waste, over burden, inter burden and top soil etc.); mining technology; lease area; scope of working (method of mining, overburden & dump management, O.B & dump mining, mineral transportation mode, ultimate depth of mining, concurrent reclamation and reclamation at mine closure; land-use of the mine lease area at various stages of mining scheme as well as at the end-of-life; etc.).	Complied	All mining activities being carried out in accordance with approved mining plan and EC conditions.
22	The land-use of the mine lease area at various stages of mining scheme as well as at the end-of-life shall be governed as per the approved Mining Plan. The excavation vis-â-vis backfilling in the mine lease area and corresponding afforestation to be raised in the reclaimed area shall be governed as per approved mining plan. PP shall ensure the monitoring and management of rehabilitated areas until the vegetation becomes self-sustaining. The compliance status shall be submitted half-yearly to the MoEFCC and its concerned Regional Office.	Complied	All the mining operations are being carried out as per approved Mine Plan including excavation and backfilling.
VI	**Land reclamation**		
23	The Overburden (O.B.) generated during the mining operations shall be stacked at earmarked OB dump site(s) only and it should not be kept active for a long period of time. The physical parameters of the OB dumps like height, width and angle of slope shall be governed as per the approved Mining Plan as per the guidelines/circulars issued by D.G.M.S w.r.t. safety in mining operations shall be strictly adhered to maintain the stability of top soil/OB dumps. The topsoil shall be used for land reclamation and plantation.	Complied	Over burden being stacked at earmarked site and after maturity same will be stabilized with plantation. Height of the OB dump is 63m , slope is 23^0 and width is 98m Slope stability study has been conducted by NIT Rourkela and is attached as **ANNEXURE XXVII**
24	The slope of dumps shall be vegetated in scientific manner with suitable native species to maintain the slope stability, prevent erosion and surface run off. The selection of local species regulates local climatic parameters and help in adaptation of plant species to the microclimate. The gullies formed on slopes should be adequately taken care of as it impacts the overall stability of dumps. The dump mass should be consolidated with the help of dozer/ compactors thereby ensuring proper filling/ levelling of dump mass. In critical areas, use of geo textiles/ geo-membranes / clay liners / Bentonite etc. shall be undertaken for stabilization of the dump.	Complied	Over burden being stacked at earmarked site and after maturity same will be stabilized with plantation.
25	Catch drains, settling tanks and siltation ponds of appropriate size shall be constructed around the mine working, mineral yards and Top Soil/OB/Waste dumps to prevent run off of water and flow of sediments directly into the water bodies (Nallah/ River/ Pond etc.). The collected water should be utilized for watering the mine area, roads, green belt development, plantation etc. The drains/ sedimentation sumps etc. shall be de-silted regularly, particularly after monsoon season, and maintained properly.	Complied	Garland drain of 4 Km has been constructed all along the haul road and 400m along the Ktesahi OB dump. Retaining wall of 500m has been provided around the OB dump. Along with this dry masonary wall of 400 m has been constructed around the S.G dump of ex-lessee. Series of settling ponds has been constructed for runoff management. Around 11 settling ponds of different dimensions has been constructed within the mine lease area.
26	Check dams of appropriate size, gradient and length shall be constructed around mine pit and OB dumps to prevent storm run-off and sediment flow into adjoining water bodies. A safety margin of 50% shall be kept for designing of sump structures over and above peak rainfall (based on 50 years' data) and maximum discharge in the mine and its adjoining area which shall also help in providing adequate retention time period thereby allowing proper settling of sediments/ silt material. The sedimentation pits/ sumps shall be constructed at the corners of the garland drains.	Complied	9 numbers of settling ponds has been constructed within the mine lease with dimension around 4m x 4m x 3m. 2 settling ponds at Guali and Gangaigoda with dimension 10m x 8m x 3m has been constructed. Check Dam along with series of 3 Settling Ponds of dimension 2m x 2m x 3m has been provided to prevent the pollution of Karo river.
VII	**Transportation**		

27	No Transportation of the minerals shall be allowed in case of roads passing through villages/ habitations. In such cases, PP shall construct a 'bypass' road for the purpose of transportation of the minerals leaving an adequate gap (say at least 200 meters) so that the adverse impact of sound and dust along with chances of accidents could be mitigated. All costs resulting from widening and strengthening of existing public road network shall be borne by the PP in consultation with nodal State Govt. Department. Transportation of minerals through road movement in case of existing village/ rural roads shall be allowed in consultation with nodal State Govt. Department only after required strengthening such that the carrying capacity of roads is increased to handle the traffic load. The pollution due to transportation load on the environment will be effectively controlled and water sprinkling will also be done regularly. Vehicular emissions shall be kept under control and regularly monitored. Project should obtain Pollution Under Control (PUC) certificate for all the vehicles from authorized pollution testing centres. (If applicable in case of road transport).	Complied	No transportation of the minerals is allowed through the roads passing through villages/ habitations. Dispatch is done only through NH. PUC check are being done on regular basis.
28	The Main haulage road within the mine lease should be provided with a permanent water sprinkling arrangement for dust suppression. Other roads within the mine lease should be wetted regularly with tanker-mounted water sprinkling system. The other areas of dust generation like crushing zone, material transfer points, material yards etc. should invariably be provided with dust suppression arrangements. The air pollution control equipment's like bag filters, vacuum suction hoods, dry fogging system etc. shall be installed at Crushers, belt- conveyors and other areas prone to air pollution. The belt conveyor should be fully covered to avoid generation of dust while transportation. PP shall take necessary measures to avoid generation of fugitive dust emissions.	Complied	Fixed water sprinkler of around 2.4 Km has been provided in part of the haul road. Water sprinkling are being doone along the haul road by two number of truck mounted tanker of reported capacity 50Kl and 16 KL Dust Suppression System (Dry fog system) has been provided at crusher and screening plant. Generation of fugitive dust emissions are controlled by regular water sprinkling on haul roads and mechanical road sweepers on concrete road, paved areas. Water sprinkling are being done on the haul road and vacuum sweeping on the national Highway to control fugitive dust.
VIII	**Green Belt**		
29	The Project Proponent shall develop greenbelt in 7.5m wide safety zone all along the mine lease boundary as per the guidelines of CPCB in order to arrest pollution emanating from mining operations within the lease. The whole Green belt shall be developed within first 5 years starting from windward side of the active mining area. The development of greenbelt shall be governed as per the EC granted by the Ministry irrespective of the stipulation made in approved mine plan.	Complied	2500 saplings were planted in FY 2021-22, and 6000 saplings were planted in FY 22-23. Gap plantation are being carried out in the safety zone.
30	The Project Proponent shall carryout plantation/ afforestation in backfilled and reclaimed area of mining lease, around water body, along the roadsides, in community areas etc. by planting the native species in consultation with the State Forest Department/ Agriculture Department/ Rural development department/ Tribal Welfare Department/ Gram Panchayat such that only those species be selected which are of use to the local people. The CPCB guidelines in this respect shall also be adhered. The density of the trees should be around 2500 saplings per Hectare. Adequate budgetary provision shall be made for protection and care of trees.	Complied	Backfilling and reclamation will be carry out as per approved mine plan. Plantation will be carried out after maturity of the same.
31	The Project Proponent shall make necessary alternative arrangements for livestock feed by developing grazing land with a view to compensate those areas which are coming within the mine lease. The development of such grazing land shall be done in consultation with the State Government. In this regard, Project Proponent should essentially implement the directions of the Hon'ble Supreme Court with regard to acquisition of grazing land. The sparse trees on such grazing ground, which provide mid-day shelter from the scorching sun, should be scrupulously guarded/ protected against	Agreed to comply	No grazing land exist within the mine lease area.

	felling and plantation of such trees should be promoted.		
IX	**Public hearing and human health issues**		
32	Project Proponent shall make provision for the housing for workers/labours or shall construct labour camps within/outside (company owned land) with necessary basic infrastructure/ facilities like fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche for kids etc. The housing may be provided in the form of temporary structures which can be removed after the completion of the project related infrastructure. The domestic waste water should be treated with STP in order to avoid contamination of underground water.	Complied	Labour camp has been provided. STP of 30 KLD has been installed for treatment of the domestic water. The treated water is being used for plantation activities. drinking water, medical health care facilities and crèche for the kids has also been provided. The housing provided is in the form of temporary structures which can be removed.
X	**Corporate Environment Responsibility (CER)**		
33	The Project Proponent shall submit the time-bound action plan to the concerned regional office of the Ministry within 6 months from the date of issuance of environmental clearance for undertaking the activities committed during public consultation by the project proponent and as discussed by the EAC, in terms of the provisions of the MoEF&CC Office Memorandum No.22-65/2017-IA.III dated 30 September, 2020. The action plan shall be implemented within three years of commencement of the project.	Being complied	Out of the total proposed budget of Rs. 1452.43 Lakhs, Nuagaon Iron Ore Mines of M/S JSW Steel ltd has done the expenditure of Rs 826 Lakhs till 31.03.2023. Details for the same is attached as **Annexure II.**
XI.	**Miscellaneous**		
34	The Project Proponent shall prepare digital map (land use & land cover) of the entire lease area once in five Years purpose of monitoring land use pattern and submit a report to concerned Regional Office of the MoEF&CC.	Complied	DGPS Surveyed Mining lease boundary superimposed on High Resolution Satellite image of Nuagaon Iron Ore Mine duly vetted by M/s ORSAC has been attached as **Annexure XII.**
35	The Project Authorities should inform to the Regional Office regarding date of financial closures and final approval of the project by the concerned authorities and the date of start of land development work.	Agreed to comply	The project authority will inform to the regional officer regarding the date of final closure of the project.
36	The Project Proponent shall submit six monthly compliance reports on the status of the implementation of the stipulated environmental safeguards to the MOEFCC &its concerned Regional Office, Central Pollution Control Board and State Pollution Control Board.	Complied	Being complied. Last six monthly compliance report along with monitoring data vide letter no JSW/S/O/2022/839 dated 30/11/2022 was submitted to Regional Office, MOEF&CC, Bhubaneswar, Zonal Office, MS and RO Offices SPCB, Odisha.
37	A separate Environmental Management Cell' with suitable qualified manpower should be set-up under the control of a Senior Executive. The Senior Executive shall directly report to Head of the Organization. Adequate number of qualified Environmental Scientists and Mining Engineers shall be appointed and submit a report to RO, MoEF&CC.	Complied	Environment Management Cell (EMC) structure has been attached as **ANNEXURE XXVIII**
38	The concerned Regional Office of the MoEF&CC shall randomly monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the MoEF&CC officer(s) by furnishing the requisite data / information /monitoring reports.	Agreed to comply	Agreed to cooperate with The concerned Regional Office of the MoEF&CC
39	In pursuant to Ministry's O.M No 22-34/2018-IA.III dated 16.01.2020 to comply with the direction made by Hon'ble Supreme Court on 8.01.2020 in W.P. (Civil) No 114/2014 in the matter Common Cause vs Union of India, the mining lease holder shall after ceasing mining operations, undertake regressing the mining area and any other area which may have been disturbed due to other mining activities and restore the land to a condition which is fit for growth of fodder, flora, fauna etc.	Agreed to comply	Will be complied.
40	The Ministry or any other competent authority may alter/modify the above conditions or stipulate any further condition in the interest of environment protection.	Noted	Noted
41	Concealing factual data failure to comply with any of submission of false/ fabricated data and of the conditions mentioned above may result in withdrawal of this clearance and attract action under the provisions of Environment (Protection) Act, 1986.	Noted	Noted

42	The above conditions will be enforced inter-alia, under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection)Act, 1986 and the Public Liability Insurance Act, 1991 along with their amendments and rules made there under and also any other orders passed by the Hon'ble Supreme Court of India/High Court and any other Court of Law relating to the subject matter.	Noted	Noted
43	Any appeal against this environmental clearance shall lie with the National Green Tribunal, if preferred, within a period of 30 days as prescribed, within a period of 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.	Noted	Noted
44	This issues with the approval of Competent Authority	Noted	Noted

Urgent
by e-mail/Fax

Government of Odisha
Department of Steel & Mines
*****

No 2291 /S&M, Bhubaneswar dated the 2 nd Mar' 2020
IV(Misc.)SM-66/2016 (Pt-I)

From

Smt. Manjulata Swain, OAS
Joint Secretary to Government

To

M/s JSW Steel Limited,
JSW Center, Bandra Kurla Complex,
Bandra (East.),Mumbai- 400051
CIN : L27102MH1994PLC152925.
E-mail:ranjan.nayak@jsw.in

Sub:- **Letter of Intent with reference to e-auction dt.31.01.2020 for grant of a mining lease for Nuagaon Block for Iron ore in Nuagaon village, Keonjhar district over 776.969 Hectare Area.**

1. **Background:**

1.1. Government of Odisha, pursuant to the Mines and Minerals (Development & Regulation) Act, 1957 (the "**Act**") and the Mineral (Auction) Rules, 2015 as amended from time to time (the "**Auction Rules**'), issued the notice inviting tender dated **06.12.2019** to commence the auction process for grant of mining lease for **Nuagaon Iron Ore Block** located in **Keonjhar** district of Odisha. The e-auction process was conducted in accordance with the tender document for the said mineral block and M/s. JSW Steel Limited was declared as the 'Preferred Bidder' under Rule 9(9)(iii) of Mineral Auction Rules, having quoted a Final Price Offer of 95.20%.

1.2. As required under rule 10(1) of the Rules and the tender document for the said mineral block, M/s. **JSW Steel Limited** has made payment of the first instalment, being 10% (ten percent) of the upfront payment of Rs. 92,84,17,368/- **(Rupees Ninety Two Crore EightyFour Lakh, Seventeen Thousand Three Hundred Sixty eight)** in shape of Treasury Challan vide e-Challan No.8088 dtd.20/02/2020 at Cyber Treasury, Dist.- Sundargarh, which was received on dated. 20/02/2020.

2. Grant of Letter of Intent

2.1 Accordingly, pursuant to Rule 10(2) of the Auction Rules and the terms of the Tender documents, the Government of Odisha is issuing this Letter of Intent for grant of mining lease for **Nuagaon Block** for **Iron Ore** in **Nuagaon** village, **Keonjhar** district over **776.969** Hectare Area to **M/s. JSW Steel Limited** for a period of 50 years.

3. **Conditions:**

3.1 This Letter of Intent and subsequent grant of aforementioned mining lease shall be subject to the provisions of the Act and the Rules made there under, as amended from time to time and **M/s. JSW Steel Limited** shall be designated as the "Successful Bidder" and subsequently granted the mining lease only upon satisfactory completion of all the requirements under the Acts and Rules made there under. **The State Government may impose such other conditions in the Mine Development and Production Agreement (MDPA) and/or Mining Lease as may be considered by the State Government to be in the interest of mineral development and in public interest**

3.2 For reference, the requirements under the Rules for designation of **M/s. JSW Steel Limited** as the "Successful Bidder" and subsequent grant of mining lease are reiterated below. It is clarified that the requirements mentioned below are only for reference and in the event of any change in the Act or the Rules made there under, the requirements under the modified Act or the Rules made there under, as the case may be, shall be applicable.

(a) **Designation as the "Successful Bidder":**

M/s. JSW Steel Limited shall be considered to be the "Successful Bidder" upon:

(i) Continuing to be in compliance with all the Terms and Conditions of the eligibility;

(ii) Payment of the second instalment being 10% (ten percent) of the upfront payment;

(iii) Furnishing performance security;

(iv) Satisfying the conditions specified in clause (b) of sub-section (2) of section (5) of the Act with respect to a Mining Plan.

(b) Signing of the Mine Development and Production Agreement:

M/s. **JSW Steel Limited** shall sign the Mine Development and Production Agreement with the Government of Odisha upon obtaining all consents, approvals, permits, no-objections and the like as may be required under applicable laws for commencement of mining operations.

(i) The Preferred Bidder/ Successful Bidder shall not:

(a) apply for environmental clearance for production of quantity of mineral which is less than the authorized annual quantity in the environmental clearance valid as on date of expiry of the immediately preceding mining lease of the said Mineral Block;

(b) seek approval for a Mining Plan for production of quantity of mineral which is less than the authorized annual quantity in the mining plan valid as on date of expiry of the immediately preceding mining lease granted in respect of the said Mineral Block:

Provided that these requirements may be relaxed by the State Government if it is satisfied that the quantity of mineral to be applied for grant of the environmental clearance or the mining plan, as the case may be, is less than the authorized annual quantity as aforesaid, entirely for reasons beyond the control of the Preferred Bidder/ Successful Bidder.

(ii) Subject to the terms and conditions of the Mining Plan and such other clearances as may be obtained by the lessee, the lessee shall be bound, during the first 2 (two) years of the Mining Lease, to produce at least 80% (eighty percent) of the average annual production of the mine computed on pro-rata basis for the last 2 (two) years of the immediately preceding mining lease of the said Mineral Block, and this will be incorporated in the MDPA as the Minimum Production Requirement:

Provided that this requirement may be relaxed by the State Government if it is satisfied that such relaxation is justified for the reasons entirely beyond the control of the lessee:

Provided further that, in case of failure to comply with this requirement, without prejudice to any other rights available to it under applicable laws and /or this MDPA, including recovery of such amount as applicable for failure to achieve the Minimum Production Requirement, the lessee may be debarred from participating in the future auction of mineral blocks conducted by the State Government for 3(three) years from the date of such debarment.

(c) **Grant of mining lease:**

Subsequent to signing of the Mine Development and Production Agreement, **M/s. JSW Steel Limited** shall make payment of the third instalment being 80% (eighty percent) of the upfront payment and thereafter the Government of Odisha shall grant the aforementioned mining lease.

4. **Validity:**

4.1 This Letter of Intent shall be valid only if **M/s. JSW Steel Limited** ensures that the Bid Security is valid until the Performance Security is furnished to the Government of Odisha.

4.2 **The M/s. JSW Steel Limited** shall fulfill all the above conditions and must execute the Mining Lease deed with the Government of Odisha at the earliest and in any case not later than such period as may be notified in the relevant laws in this regard. In case there is a delay in execution of Mining Lease Deed due to reasons beyond the control of the Preferred Bidder, then it may submit an application to Government of Odisha as per the applicable provisions of relevant laws in this regard, requesting for further extension. Such application will be dealt in accordance with the provisions of relevant laws.

4.3 In case the Preferred Bidder/ Successful Bidder is not able to execute the mining lease deed within the period mentioned in Clause 4.2 above, the Bid Security or the Performance Security, as the case may be, and any instalments of upfront payment paid shall be forfeited. Further, the Preferred Bidder/ Successful Bidder may be debarred from participating in the future auction of mineral blocks conducted by the State Government for 3 (three) years from the date of such debarment.

4.4 **M/s. JSW Steel Limited** shall furnish acceptance of the terms and conditions of Letter of Intent with Board Resolution within 15 (fifteen) days from the date of issue of this letter.

4.5 This Letter of Intent is subject to the result of the Writ Petition (Civil) No.25085 of 2019 (Er. Rainy Rose- Vrs.- Union of India and Others) pending before the Hon'ble High Court of Orissa, as ordered vide its Interim Order dtd.02.01.2020.

Yours faithfully

2/3/2020
Joint Secretary to Government

Memo No 2292 /S&M, Bhubaneswar dated the 2 nd Mar' 2020

Copy forwarded to the Director of Mines, Odisha, BBSR with reference to his letter No.1728/DM dtd 24/02/2020 and Memo No.1375/DM dtd.15/02/2020 for information and necessary action.

2/3/2020
Joint Secretary to Govt

Memo No 2293 /S&M, Bhubaneswar dated the 2 nd Mar' 2020

Copy forwarded to the Collector, Keonjhar/ DDM, Joda for information and necessary action.

2/3/2020
Joint Secretary to Govt.

Government of Odisha
Steel and Mines Department

****

VESTING ORDER

No. 4167 /SM   Dated the 29th May 2020
III(A)SM-01/2020

Whereas a mining lease of the following description, which was held by M/s KJS Ahluwalia (hereinafter referred to as the previous lessee) with validity period upto 31.03.2020 has been auctioned and M/s JSW Steel Ltd., has been declared as the preferred bidder of the said mine.

Description of the Mining Block

- Name of Mineral(s) - Iron
- Name of Mining lease - Nuagaon Iron Block.
- Address/location of mining lease - Village Nuagaon under Barbil Tahasil of Keonjhar district.
- Area of lease - 776.969 hects (As per DGPS)/ 767.284 hects(As per ROR).

And whereas, a letter of intent bearing no 2291 dated 02.03.2020 has been issued in favour of the preferred bidder for grant of mining lease for the above mentioned mining block;

And whereas, in terms of section 8B(2) of the MMDR Act, 1957 read with rule 9A(4) of the Mineral (Other than Atomic and Hydrocarbon Energy Minerals) Concession Rules, 2016 [herein after called the Rules'2016], the holder of the letter of intent for the said mining block shall be deemed to have acquired all valid rights, approvals, clearances, licenses and the like vested with the previous lessee.

Now therefore, the undersigned being the Nodal Officer for the State of Odisha having been nominated under rule 9A(1) of the Mineral (Other than Atomic and Hydrocarbon Energy Minerals) Concession Rules, 2016 [herein after called the Rules,2016], do hereby, pursuant to the provisions contained in rule 9A(2) of the Rules,2016 order that all the valid rights, approvals, clearances, licenses and the like vested in the previous lessee in respect of the aforementioned mining block are deemed to have vested in favour of the holder of the letter of intent on the same terms and conditions of every rights, approvals, clearances, licenses, and the like which vested with previous lessee.

Without prejudice to the generality of the provisions of section 8B(2) of the MMDR Act, 1957, the details of the valid rights, approvals, clearances, licenses, and the like held by the previous lessee and vested in favour of the holder of the Letter of Intent are given in the Annexure-I to this order.

This vesting order is valid for a period of two years from the date of execution of lease deed or till the date of getting fresh approvals, clearances, licenses, permits, and the like, whichever is earlier

(S. K. Popli)
Nodal Officer-cum-Special Secretary to Government

Memo No. 4168 / SM Dated: 29th May 2020

Copy to alongwith Annexure-I forwarded to M/s JSW Steel Ltd, JSW Centre, Bandra Kurla Complex, Bandra (East), Mumbai- 400051 for information and necessary action. It is requested that one copy each of the documents mentioned in the Annexure-I may be collected from the office of the Director Mines, Odisha, Bhubaneswar during office working hours.

Nodal Officer

Memo No. 4169 /SM Dated: 29th May 2020

Copy to alongwith Annexure-I forwarded to M/s KJS Ahluwalia, P.B No-3, Barbil, Keonjhar- 758035, Odisha for information and necessary action.

Nodal Officer

Memo No. 4170 / SM Dated: 29th May 2020

Copy alongwith Annexure-I forwarded to Indian Bureau of Mines, Bhubaneswar/ MoEF & CC, 534, Paryavaran Bhawan, CGO Complex, Lodhi Road, New Delhi 110003/ MoEF & CC (FC Divison), Indira Paryavaran Bhawan, Aliganj, Jorbagh Road, New Delhi 110003/ SPCB, Parivesh Bhawan, A/118, Nilakantha Nagar, Unit-VIII, Bhubaneswar, Odisha, 751012/ Director General of Mines Safety, Chaibasa Regiona, Chaibasa, 833201 /Ministry of Water Resource, River Development and Ganga Rejuvenation, West Block-2, Wing 3, Sector-1, R.K. Puram, New Delhi-110066 for information and necessary action.

Nodal Officer

Memo No. 4171 / SM Date: 29th May 2020

Copy alongwith Annexure-I forwarded to Director of Mines, Odisha, Bhubaneswar for information and necessary action. He is requested to provide one copy each of the documents described in the Annexure-I to the authorized representative of the LoI holder with proper acknowledgement and forward a copy of acknowledgement to the Department for record.

Nodal Officer

Memo No. 4172 / SM Date: 29th May 2020

Copy alongwith Annexure-I forwarded to Collector, Keonjhar/ Deputy Director of Mines, Joda / DFO, Keonjhar for information and necessary action.

Nodal Officer

Memo No. 4173 / SM Date: 29th May 2020

Copy alongwith Annexure-I forwarded to Forest and Environment Department/ PCCF(Nodal), Bhubaneswar for information and necessary action.

Nodal Officer

ANNEXURE-I

Name of the Block : **/aon Iron ore Block**
LoI Holder : **JSW Steel Ltd**
Area of the Lease : **767.284 Hects (As per ROR)**
776.969 hects (As per DGPS)

SL No	Nature of approval clearance etc	Issuing officer/authority	Reference No./ Date of Issue
1	Mining Plan	Regional Controller of Mines, Bhubaneswar, Govt. of India	MSM/FM/48-ORI/BHU/2017-18/322, Dated 23.04.2018.
2	EC	MoEF & CC, Govt. of India	J-11015/1156/2007-IA II(M),Dtd 02.02.10 J-11015/317/2009-IA II(M),Dtd 16.02.12
3	FC	MoEF & CC, Govt. of India,	F. No. 8-17/2001-FC, Dtd. 21/22.04.2004 over 476.205
4	Consent to Establish	State Pollution Control Board, Odisha	14617/IND-II-NOC-5421, Dated 03.09.2015
5	Consent to Operate	State Pollution Control Board, Odisha	3500-IND-I-CON-2320, Dated 27.02.2016
6	Surface Right	District Collector, Keonjhar	Surface Right granted over 416.604 hects
7	Deep Hole Blasting & use of HEMM	Directorate General of Mines Safety, Chaibasa Region, Chaibasa, Govt. of India	Memo No-330131/1501, Dated 06.06.2017, Letter No-CR/443, Dtd. 29.01.03
8	Ground Water Withdrawal	Member Secretary (CGWA), Central Ground Water Authority , Govt. of India	21-4(92)/SER/CGWA/2008/1831, Dtd. 03.11.17

1. Vesting of clearances/approvals/licences/permissions /rights as above does not have the effect of transfer of ownership of infrastructure established and the ore & minerals raised by the ex-lessee which shall be governed by the provisions of the rules 12(1)(gg) and 12(1)(hh) of the Minerals Concession Rules, 2016. However, on acquisition of such infrastructure from the ex-lessee and submission of evidence thereof, the new lessee may be vested with related clearances/ approvals etc at the relevant time.
2. Vesting of Forest Clearance is subject to payment of NPV as prescribed in letter dtd. 31.03.2020 of Government of India, Ministry of Environment, Forest & Climate Change.

29/5/2020

GOVERNMENT OF ODISHA
STEEL AND MINES DEPARTMENT
*****

ORDER

No. 1303 /SM, Dated 15.02.2022
SM-MC1-MRL-0002-2020

Whereas in pursuance to the "invitation of bids for grant of Mining Lease for Iron ore" dated 06.12.2019 issued by the Government and subsequent auction held on dated 31.01.2020, M/s. JSW Steel Ltd., the successful bidder has been granted a mining lease for Iron ore in respect of Nuagaon Iron ore block over an area of 776.969 hects (as per DGPS)/767.284 hects (as per RoR) in village Nuagaon of Kenjhar district for the period of 50 (Fifty) years as provided under section 8A, sub-section 2 of the Mines and Minerals Development and Regulation Act, 1957 vide order No 5443/SM, dated 26.06.2020.

And whereas, the lease deed has been executed and registered by the lessee.

And whereas, the new lessee was vested with all the valid rights, approvals, clearances, licences and the like vested in the previous lessee for a period of 2 (Two) years vide vesting order no. 4167/SM, dated 29.05.2020, order no 9801/SM, dated 13.11.2020 and order no 455/SM, dated 13.01.2021.

And whereas, in the meantime section 8B of the MMDR Act, 1957 and Rule 9A of M.C. Rules, 2016 have been amended w.e.f 28.03.2021 and 02.11.2021 respectively as noted below.

"8B (1); Notwithstanding anything contained in this Act or any other law for the time being in force, all valid rights approvals, clearances, licenses and the like granted to a lessee in respect of a mine (other than those granted under the provisions of the Atomic Energy Act, 1962 and

the rules made thereunder) shall continue to be valid even after expiry or termination of lease and such rights, approvals, clearances, licenses and the like shall be transferred to and vested, subject to the conditions provided under such laws, in the successful bidder of the mining lease selected through auction under this Act.

Rule 9A (1) in sub-rule (1), for "in respect of leases expiring under the provisions of sub-sections (5) and (6) of section 8A of the Act, within one week from the date of the notification of the Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession (Amendment) Rules, 2020" the words, figure and letter, "for the purpose of issuing vesting order for transfer and vesting of all valid rights, approvals, clearances, licences and the like in accordance with sub section (1) of section 8B" shall be substituted,

Rule 9A (5); It shall be lawful for the new lessee to commence and continue mining operation on the land in which mining operations were being carried out by the pervious lessee, after the execution of the lease deed till expiry or termination of mining lease granted".

And whereas, the Director of Mines vide letter No. 10120/DM, dated 22.12.2021 has proposed to issue the modified vesting and transfer order in respect of Nuagaon Iron Ore mines of M/s JSW Steel Limited.

Now therefore, in partial modification of the order as communicated vide vesting order no 4167/SM, dated 29.05.2020, order no 9801/SM, dated 13.11.2020 and order no 455/SM, dated 13.01.2021, the undersigned being the Nodal Office for the State of Odisha having been nominated under rule 9A(1) of the Mineral (Other than Atomic and Hydrocarbon Energy Minerals) Concessions Rules, 2016 (herein after called the Rules 2016], do hereby, pursuant to the provisions contained in rule 9A(2) of the Rules, 2016 order that all the valid rights, approvals, clearances, licences and the like vested in the previous lessee in respect of the aforementioned mining block are deemed to have vested and transferred in favour of the holder of the letter of intent on the same terms and conditions of every rights, approvals, clearances, licences and the like which vested with previous lessee till expiry or termination of mining lease granted.

15/2/2022

(D. Mohanty)
Nodal Officer & OSD-cum-Special Secretary to Government

Memo No. 1304 **/SM** **Dated:** 15.02.2022

Copy forwarded to M/s JSW Steel Ltd, JSW Centre, Bandra Kurla Complex, Bandra (East), Mumbai- 400051 for information and necessary action.

15/2/2022

Nodal Officer

Memo No. 1305 **/SM** **Dated:** 15.02.2022

Copy forwarded to Director of Mines, Odisha, Bhubaneswar for information and necessary action.

15/2/2022

Nodal Officer

Memo No. 1306 **/SM** **Dated:** 15.02.2022

Copy forwarded to Collector, Keonjhar/ DFO, Keonjhar/ Joint Director of Mines, Joda for information and necessary action.

15/2/2022

Nodal Officer

Memo No. 1307 **/SM** **Dated:** 15.02.2022

Copy forwarded to Forest and Environment Department/ PCCF(Nodal), Bhubaneswar/ Regional Controller of Mines, Indian Bureau of Mines, Bhubaneswar for information and necessary action.

15/2/2022

Nodal Officer

By Speed Post/ e-mail

GOVERNMENT OF ODISHA

FOREST, ENVIRONMENT & CLIMATE CHANGE DEPARTMENT

*****

No.FE-DIV-FLD-0120-2021-7489/FE&CC, Date 21-04-22

10F (Cons) 138/2015

From

Lingaraj Otta,

OSD-cum-Special Secretary to Government

To

The Principal Chief Conservator of Forests & HoFF, Odisha,

Bhubaneswar.

Sub: Transfer of FC approval granted under the Forest (Conservation) Act, 1980 for mining lease from Old lessee M/s KJS Ahluwalia to New Lessee M/s JSW Steel Ltd as per the provision of the Mines and Minerals (Development and Regulation) Amendment Act, 2021 in respect of Nuagaon Iron Ore Block under Keonjhar Forest Division, Barbil Tahasil, Dist-Keonjhar for diversion of 371.192 ha of forest land

Sir,

I am directed to invite a reference to your letter No.5696/9F(MG)-76/2021 dtd.17.03.2022 seeking transfer of FC approval granted under the Forest (Conservation) Act, 1980 for mining lease from Old lessee M/s KJS Ahluwalia to New Lessee M/s JSW Steel Ltd as per the provision of the Mines and Minerals (Development and Regulation) Amendment Act, 2021 in respect of Nuagaon Iron Ore Block under Keonjhar Forest Division, Barbil Tahasil, Dist-Keonjhar for diversion of 371.192 ha of forest land and with reference to letter File No.FC-11/112/2020-FC (Pt) dtd.07.07.2021 of Govt. of India, MoEF&CC, FC Division, New Delhi.

After careful consideration of your proposal and in pursuance of the guidelines issued by Govt. of India, MoEF &CC vide File No. FC-11/112/2020-FC (Pt) Dated 7th July, 2021, the transfer of approval granted by Govt. of India, MoEF&CC under Section-2 of the Forest (Conservation) Act, 1980 vide F. No.8-17/2001-FC dtd.22.04.2004 from the erstwhile User Agency M/s KJS Ahluwalia to

M/s JSW Steel Ltd is hereby accorded by the State Govt. for non-forestry use of 371.192 ha of forest land for mining in Nuagaon Iron Ore under Keonjhar Forest Division, Barbil Tahasil, Dist-Keonjhar, Odisha subject to fulfilment of the following conditions.

i. DGPS Survey of 371.192 ha of diverted forest area shall be done by the user agency and the same may be ensured by the DFO, Keonjhar Forest Division in the field before handing over the area.

ii. The DFO, Keonjhar Forest Division shall upload the KML files of the area under diversion and the accepted non-forest land for raising Compensatory Afforestation in the E-Green Watch portal of FSI before handing over forest land to the new lessee.

iii. Erstwhile lessee has deposited the NPV over 639.823 ha forest land which includes the diverted forest area of 371.192 ha. The amount deposited by the new lessee @ Rs.7.50 Lakh per ha is the lumpsum amount realized by State Government on issue of LoI (for the total forest area within the mining lease), which may be adjusted towards balance NPV if any and any compensatory levies payable in future.

iv. The new lessee shall furnish an undertaking to pay the additional NPV, if so determined, as per the decision of the Hon'ble Supreme Court of India.

v. The new lessee shall also comply the non-complied conditions and if any by Govt. of India, MoEF & CC, IRO, Bhubaneswar, after conducting the inspection of the area for the appraisal of compliance of approval granted under Forest (Conservation) Act, 1980.

vi. The new lessee, after ceasing mining operation, undertake re-grassing the mining area and any other areas which may have been disturbed due to their mining activities and restore the land to a condition which is fit for growth of fodder, flora, fauna etc.

vii. Forest Clearance over 276.297 ha forest land will be transferred to the new lessee after issue of FC transfer order and forest clearance over 94.895 ha will be transferred to the new lessee after acceptance of the CA land by the DFO, Keonjhar Forest Division as per the extant procedure for acceptance of CA land.

viii. The new lessee shall take steps to obtain approval of Govt. of India for diversion of the balance forest area of 255.103 ha (both DGPS and RoR) (626.295 ha – 371.192 ha) under Section 2 (ii) of FC Act, 1980.

ix. Execution of project activities by the new lessee will be subject to availability of all other statutory clearances required under relevant Acts/Rules for this mining project and compliance of Court's order, if any.

Yours faithfully,

21/4/2022

OSD-cum-Special Secretary to Government

FE-DIV-FLD-0120-2021/5/2022

Memo No. 7490 /FE&CC, Date 21-04-22

Copy forwarded to the Assistant Inspector General of Forests (FC), Government of India, Ministry of Environment, Forests & Climate Change (F.C. Division), Indira Paryavaran Bhawan, Aliganj, Jor Bagh Road, New Delhi-110003 for information and necessary action.

Sd/- 21/4/2022

OSD-cum-Special Secretary to Government

Memo No. 7491 /FE&CC, Date 21-04-22

Copy forwarded to the Deputy Director General of Forests (Central), Govt. of India, MoEF&CC, IRO, A/3, Chandrasekharpur, Bhubaneswar for information and necessary action.

Sd/- 21/4/2022

OSD-cum-Special Secretary to Government

Memo No. 7492 /FE&CC, Date 21-04-22

Copy forwarded to the Principal Chief Conservator of Forests (Wildlife) & Chief Wildlife Warden, Odisha / Chief Conservator of Forests (FD&NO), FC Act, O/o PCCF & HoFF, Odisha for information and necessary action.

Sd/- 21/4/2022

OSD-cum-Special Secretary to Government

Memo No. 7493 /FE&CC, Date 21-04-22

Copy forwarded to the Regional Chief Conservator of Forests, Rourkela Circle/ Divisional Forest Officer, Keonjhar Forest Division for information and necessary action.

Sd/- 21/4/2022

OSD-cum-Special Secretary to Government

Memo No. 7494 /FE&CC, Date 21-04-22

Copy forwarded to Steel & Mines Department/ R&DM Department/ Director Environment-cum-Special Secretary to Government, FE&CC Department/ Director of Mines, Odisha/ Member Secretary, SPCB, Odisha/ Collector, Keonjhar for information and necessary action.

Sd/- 21/4/2022

OSD-cum-Special Secretary to Government

Memo No. 7495 /FE&CC, Date 21-04-22

Copy forwarded to the Authorized Signatory, M/s JSW Steel Ltd, Plot No.3, Forest Park, Sishu Bhawan Square, Bhubaneswar-751009 for information and necessary action.

dt 21/4/2022

OSD-cum-Special Secretary to Government

Memo No. 7496 /FE&CC, Date 21-04-22

Copy forwarded to M/s KJS Ahluwalia, Mines Owner & Exporter, PB No.3, Infront of MMTC Weigh Bridge, At/Po-Barbil, Dist-Keonjhar, Odisha, Pin-758035 for information and necessary action.

dt 21/4/2022

OSD-cum-Special Secretary to Government

NUAGAON IRON ORE MINES

CER Cost Breakup with Activities						
SL NO.	ITEMS	TOTAL AMOUNT for Committed CER in Lakh	TOTAL AMOUNT (FY 20 - 21)	TOTAL AMOUNT (FY 21 - 22)	TOTAL AMOUNT (FY 22 - 23)	
1	Infrastructure Development	731.27	6716380	17996155	7284265	
2	Health Infrastructure & Services	90	2238725	12200000	9184865	
3	Education Infrastructure & Support	260.9	1687336	2219329	10385067	
4	Sustainable Livelihood	205.2	0	887750	1510040	
5	Vocational Training	71.06	0	0	362268	
6	Special Program	94	100000	138263	9690130	
	Total	**1452.43**	**10742441**	**33441497**	**38416635**	**82600573**
						826 Lakhs

PLANTATION


X76X+XR7, Kolharodkala, Odisha 758035, India
Latitude 21.962776° Longitude 85.299861°
LOCAL 11:56:41 GMT 06:26:41 SATURDAY 04.23.2022 ALTITUDE 616 METER

Retaining wall/Garland drain/Settling Pond


t on realme 8 5G

280

OFFICE OF THE PRINCIPAL CCF (WILDLIFE) & CHIEF WILDLIFE WARDEN,ORISSA5TH FLOOR, B.D.A. APARTMENT, PRAKRUTI BHAWAN, NILAKANTHA NAGAR, BHUBANESWAR- 751012.

Memo No.________ Dt.
1WL-C-FC-386/08

OFFICE OF THE DIVISIONAL FOREST OFFICER
R. No 850
Date 03-02-09
KEONJHAR DIVISION (T)

To

The Chief Conservator of Forests (Nodal),
O/o PCCF, Orissa, Bhubaneswar.

Sub: Approval of Site Specific Wildlife Conservtion Plan, Authentication of Location Map and the list of Flora & Fauna. found in core zone and Buffer zone of Nuagaon Iron Ore Mines of M/s Kamaljeet Singh Ahluwalia.

Ref: Govt. of India, MOEF letter No.J-11015/1156/2007-IA.II(M) dt. 8.5.08.

In inviting a reference to the above mentioned subject, I am directed to inform you that the site specific wildlife conservation plan for Nuagaon Iron Ore Mines of M/s Kamaljeet Singh Ahluwalia in the Keonjhar district of Orissa has been approved by the Principal CCF(WL) & Chief Wildlife Warden, Orissa for Rs.348 lakhs for activities both inside and outside the project area and the above scheme is to be implemented by DFO, Keonjhar with funding from the Project proponent. The approved Conservation Plan in two numbers along with authenticated location map of the project are enclosed herewith for necessary action at your end.

Sd/-
Conservator of Forests (WL)

Memo No. 547 Dt. 28-1-09

Copy along with approved site specific wildlife conservation plan forwarded to DFO, Keonjhar Division for information & necessary action with reference to his Memo No. 4144 dt. 19.11.08 of CF, Rourakela Circle.

Conservator of Forests (WL)

Memo No.________Dt.

Copy to C.F., Rourakela Circle for information & necessary action with reference to his Memo No.4142 dt. 19.11.08.

Conservator of Forests (WL

Memo No.________Dt.

Copy along with along with authenticated location map of the project & approved flora & fauna list forwarded to M/s Kamaljeet Singh Ahluwalia, P.O- Barbil, Dist, Keonjhar for information & necessary action with reference to his letter dated 11.12.2008.

Conservator of Forests (WL)

OFFICE OF THE DIVISIONAL FOREST OFFICER, KEONJHAR DIVISION
Ph. No. 06766-254315, E.mail- dfokjr.od@gov.in

No. 3877 /6F-Mining- 33 /2020
Dated, Keonjhar the 05-07 /2021

To

Baswaraj Mahadevppa Dalgade, Authorised Signatory,
Asst. General Manager (Project),
M/s JSW Steel Limited, JSW Centre Bandra Kurla Complex,
Bandra East, Mumbai, PIN-400051,
E-mail: baswaraj.dalgade@jsw.in

Sub: Request for issuance of implementation certificate of approved of site specific wildlife plan in favour of erstwhile lessee M/s K.J.S Ahluwalia for Nuagaon Iron Ore Mines of M/s JSW Steel Ltd.

Ref: Your letter No.JSW/S/O/2021/154 dated 18.06.2021.

Sir,

With reference to your above cited letter on the captioned subject, the details information on approved site specific wildlife conservation plan in respect of Nuagaon Iron Ore Mines of M/s K.J.S Ahluwalia is furnished below.

Approved amount of SSWCP (in lakh)		Total	Approved Letter No. / date of PCCF(WL) & CWLW,Odisha	Approved demanded Amount	Date of Deposit	UTR No. / NEFT
Project Area	Project Impact Area					
90.00	258.00	348.00	No.549 dated 18.01.2009	258.00	07.12.2011	UTIBH11341017089

Further, this is to intimate that, no funds has been released till date from CAMPA & implementation of the above approved SSWCP by the undersigned in project impact area is nil.

This is for your information and necessary action.

Yours faithfully,

05/07/2021

Divisional Forest Officer,
Keonjhar Division.

SUMMARY

OF

ENVIRONMENTAL MONITORING REPORT

(OCTOBER 2022 TO MARCH 2023)

FOR

NUAGAON IRON ORE MINE

DISTRICT—KEONJHAR, ODISHA

OF

M/S JSW STEEL LIMITED, ODISHA

ENV MONITORING CARRIED OUT

BY

ECOMEN LABORATORIES PVT.LTD

Ecomen Laboratories Pvt. Ltd.
(An approved Laboratory from MoEF & CC & NABL)
B-1/8, Sector-H, Aliganj, Lucknow 226 024 (U.P.)
Phone No.: (91-522) 2746282; Fax No.: (91-522) 2745726
E-mail: contactus@ecomen.in

Environmental Monitoring Report- Nuagaon Iron Ore Mines of M/s JSW Steel Limited, Odisha during the period (October 2022 to March 2023)

1. Ambient Air Quality Lease Area

Sl. No.	Location	Month	Concentration	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	SO_2 µg/m³	NO_2 µg/m³	CO mg/m³
1.	Near LP99 (Near Creche)	Oct'22	Maximum	49.9	17.9	14.9	17.9	0.59
			Minimum	42.8	13.1	12.1	14.2	0.48
			Average	46.0	15.3	13.9	16.1	0.5
		Nov'22	Maximum	43.7	16.5	14.9	17.9	0.5
			Minimum	35.4	13.3	12.1	14.4	0.41
			Average	39.1	15.0	13.7	16.4	0.5
		Dec'22	Maximum	48.7	18.0	14.8	15.8	0.5
			Minimum	41.1	14.0	12	12.4	0.42
			Average	45.2	16.1	13.5	13.8	0.5
		Jan'23	Maximum	61.0	18.4	18.0	15.9	0.49
			Minimum	53.9	12.6	15.2	13.0	0.42
			Average	57.5	15.5	16.7	14.4	0.4
		Feb'23	Maximum	70.8	21.8	17.8	16.7	0.5
			Minimum	65.0	14.9	15.0	14.2	0.41
			Average	68.0	17.5	16.4	15.5	0.5
		March'23	Maximum	77.4	31.6	13.5	28.6	0.72
			Minimum	51.4	20.1	9.9	19.3	0.36
			Average	60.7	24.5	11.6	23.1	0.6
		Oct'22	Maximum	49.8	17.7	14.8	17.7	0.6
			Minimum	42.1	13.1	12.1	14.2	0.48
			Average	45.3	15.6	13.7	15.9	0.5
CPCB Standard			**24 Hrly**	**100**	**60**	**80**	**80**	**4 (1Hrly)**

Sl. No	Location	Month	Concentration	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	SO_2 µg/m³	NO_2 µg/m³	CO mg/m³
2.	**Near Mines Office**	Nov'22	Maximum	42.8	16.6	14.8	18.3	0.49
			Minimum	35	13.7	12.3	14.2	0.41
			Average	38.6	14.9	13.4	16.2	0.5
		Dec'22	Maximum	48.8	18	15	15.8	0.5
			Minimum	41.3	14.2	12	12.1	0.42
			Average	44.7	16.1	13.8	14.1	0.4
		Jan'23	Maximum	60.6	18.9	18	16	0.5
			Minimum	53.3	12.3	15.1	13	0.41
			Average	57.3	15.5	16.5	14.3	0.5
		Feb'23	Maximum	70.9	21.5	17.9	16.8	0.5
			Minimum	65.0	15.1	15	14	0.41
			Average	67.6	17.8	16.3	15.4	0.5
		March'23	Maximum	77.6	30.1	16.5	28.3	0.68
			Minimum	53.5	19.1	10.7	21.5	0.39
			Average	65.4	25.5	13.0	24.8	0.5
3.	Near Dispensary	Oct'22	Maximum	49.8	16.8	15.5	17.7	0.6
			Minimum	42.3	13.5	12.2	14.1	0.48
			Average	46.8	15.3	13.9	16.0	0.5
		Nov'22	Maximum	42.6	17.8	14.9	17.9	0.5
			Minimum	36.3	13.2	12.2	14.1	0.41
			Average	39.7	15.2	13.5	15.9	0.5
		Dec'22	Maximum	48.9	18	15	15.9	0.49
			Minimum	41.1	14.4	12.3	12.1	0.41
			Average	45.5	16.2	13.6	14.0	0.5
		Jan'23	Maximum	60.9	18.7	17.9	16	0.49
			Minimum	53.1	12.1	15	13	0.41
			Average	56.8	15.1	16.4	14.4	0.5
			Maximum	70.6	21.8	17.7	16.9	0.5

		Feb'23	Minimum	65	15.1	15	14.1	0.41
			Average	68.0	18.1	16.4	15.4	0.5
		March'23	Maximum	72.9	30.5	19	26.5	0.61
			Minimum	48.5	22	11	19.2	0.3
			Average	60.0	25.0	14.1	21.6	0.5
CPCB Standard			**24 Hrly**	**100**	**60**	**80**	**80**	**4 (1Hrly)**

Sl. No	Location	Month	Concentration	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	SO_2 µg/m³	NO_2 µg/m³	CO mg/m³
4.	Near Katesahi Exit Gate	Oct'22	Maximum	49.9	16.4	14.8	17.9	0.6
			Minimum	42.2	13.1	12.1	14.3	0.48
			Average	45.6	14.7	13.4	15.9	0.5
		Nov'22	Maximum	43.7	16.9	15.4	17.7	0.5
			Minimum	36.7	13.4	12.3	14.1	0.41
			Average	39.3	15.3	13.6	16.0	0.5
		Dec'22	Maximum	48.2	17.8	14.9	15.5	0.49
			Minimum	41.2	14.1	12.2	12.2	0.41
			Average	44.7	15.8	13.4	13.5	0.5
		Jan'23	Maximum	60.6	18.4	17.9	16	0.5
			Minimum	53.9	12.2	15	13.1	0.41
			Average	56.9	15.2	16.5	15.0	0.5
		Feb'23	Maximum	70.3	21.7	17.9	16.8	0.5
			Minimum	65.5	15.1	15	14	0.41
			Average	67.6	17.9	16.4	15.6	0.5
		March'23	Maximum	85.1	40.7	20.9	40.3	0.71
			Minimum	61.6	25.8	12.9	21.3	0.28
			Average	76.1	32.8	17.7	33.8	0.4

CPCB Standard	24 Hrly	100	60	80	80	4 (1Hrly)

2. Ambient Air Quality Buffer Area

Sl. No	Location	Month	Concentration	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	SO_2 µg/m³	NO_2 µg/m³	CO mg/m³
1.	Panduliposhi Village	Oct'22	Maximum	56.2	18.7	13.6	18.9	0.61
			Minimum	51.4	14.1	12.5	15.5	0.49
			Average	53.6	16.7	13.0	16.8	0.6
		Nov'22	Maximum	46.2	17.4	13.2	18.6	0.59
			Minimum	42.6	14.4	12.1	15.9	0.53
			Average	44.4	15.6	12.7	17.3	0.6
		Dec'22	Maximum	56.9	18.3	16.9	16.8	0.6
			Minimum	51.8	16.1	14.5	13.4	0.5
			Average	54.5	17.5	15.5	15.3	0.6
		Jan'23	Maximum	62.5	20.7	16.7	18.7	0.61
			Minimum	57.5	17.6	15.4	15	0.49
			Average	60.3	19.3	16.0	17.0	0.5
		Feb'23	Maximum	70.6	21.5	16.9	18	0.6
			Minimum	65.9	17.6	15.1	15	0.5
			Average	68.0	19.3	16.1	16.5	0.6
		March'23	Maximum	98.9	53.5	22.11	35	0.64
			Minimum	85.8	36.6	18.5	28.7	0.52
			Average	92.2	43.6	20.4	33.0	0.6
CPCB Standard			24 Hrly	100	60	80	80	4 (1Hrly)

Sl. No	Location	Month	Concentration	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	SO_2 µg/m³	NO_2 µg/m³	CO mg/m³
2.	Katesahi Village	Oct'22	Maximum	56.7	17.9	13.9	19.4	0.61
			Minimum	51.3	15.2	12.1	15.2	0.48
			Average	53.9	16.7	12.9	17.3	0.5
		Nov'22	Maximum	47.5	17.9	13.7	18.7	0.59
			Minimum	43.9	14.6	12.3	15.1	0.5
			Average	45.4	15.8	13.0	17.2	0.5
		Dec'22	Maximum	56.9	18.4	16.8	16.2	0.59
			Minimum	51.4	16.3	14.1	13.2	0.49
			Average	53.8	17.3	15.9	14.8	0.5
		Jan'23	Maximum	59.4	18.9	16.1	17.5	0.5
			Minimum	59.4	18.9	16.1	17.5	0.5
			Average	59.4	18.9	16.1	17.5	0.5
		Feb'23	Maximum	70.3	20.9	167	18.9	0.65
			Minimum	65.8	17.3	15.1	16.4	0.5
			Average	68.1	18.8	34.8	17.6	0.6
		March'23	Maximum	89	54.6	25.2	45	0.61
			Minimum	76.5	44.5	23.1	38.7	0.54
			Average	82.8	50.3	24.1	43.0	0.6
CPCB Standard			**24 Hrly**	**100**	**60**	**80**	**80**	**4 (1Hrly)**

Sl. No	Location	Month	Concentration	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	SO_2 µg/m³	NO_2 µg/m³	CO mg/m³
3.	Barpada Village	Oct'22	Maximum	56.9	16.8	14.2	17.7	0.61
			Minimum	51.8	14.4	12.1	15.3	0.49
			Average	54.9	15.7	13.2	17.0	0.6
		Nov'22	Maximum	48.3	17.5	13.9	18.4	0.57
			Minimum	44.1	14.6	12.2	15.4	0.48
			Average	45.6	15.8	12.9	16.1	0.5
		Dec'22	Maximum	57.0	18.8	16.3	16.3	0.59
			Minimum	52.8	16.1	14.4	13.3	0.5
			Average	54.6	18.0	15.3	15.0	0.6
		Jan'23	Maximum	62.7	20.7	16.7	19	0.61
			Minimum	57.1	18.1	15.5	15.3	0.49
			Average	60.6	19.5	15.9	17.4	0.6
		Feb'23	Maximum	70.7	20.9	16.7	18.9	0.6
			Minimum	65.0	18.4	15	16.1	0.52
			Average	67.9	19.4	15.9	17.6	0.6
		March'23	Maximum	96	60.6	28.2	48.5	0.6
			Minimum	81.5	48.5	26.1	40.8	0.47
			Average	86.6	53.4	27.1	44.8	0.5
CPCB Standard			**24 Hrly**	**100**	**60**	**80**	**80**	**4 (1Hrly)**

Sl. No	Location	Month	Concentration	PM_{10} µg/m^3	$PM_{2.5}$ µg/m^3	SO_2 µg/m^3	NO_2 µg/m^3	CO mg/m^3
4.	Rengelabeda Village	Oct'22	Maximum	55.1	16.9	13.9	18.9	0.61
			Minimum	51.1	14.1	12.5	16.2	0.51
			Average	53.7	15.2	13.3	18.0	0.6
		Nov'22	Maximum	47.5	17.8	13.5	18.5	0.59
			Minimum	41.8	14.1	12.1	15.4	0.48
			Average	44.7	16.2	12.8	16.6	0.5
		Dec'22	Maximum	56.8	18.4	16.7	15.6	0.6
			Minimum	51.4	16.1	14	13.3	0.48
			Average	53.5	17.2	15.7	14.5	0.5
		Jan'23	Maximum	61.6	20.3	16.7	18.7	0.6
			Minimum	57.2	17	15	15.3	0.49
			Average	59.1	18.6	15.8	17.3	0.6
		Feb'23	Maximum	70.1	20.5	16.7	18.4	0.6
			Minimum	65.6	17.4	15.1	15.3	0.51
			Average	68.1	18.9	16.0	16.9	0.6
		March'23	Maximum	87.5	53.5	24.5	43.5	0.61
			Minimum	76.5	44.5	20	32	0.53
			Average	81.2	49.7	23.0	39.0	0.6
CPCB Standard			**24 Hrly**	**100**	**60**	**80**	**80**	**4 (1Hrly)**

3. Fugitive Emission Monitoring (μg/m³)

Sl. No.	Month	Crusher Plant		Mines Haulage Road		Screen Plant	
		Max	Min	Max	Min	Max	Min
1.	Oct'22	543.1	450.6	539.6	457.8	545.4	452.1
2.	Nov'22	549.2	451.4	548.5	460.3	548.2	453.1
3.	Dec'22	628.1	530.5	629.3	531.1	628	537.6
4.	Jan'23	678.3	582.3	679.9	580.5	679.4	581.4
5.	Feb'23	797.6	625.1	789.1	609.5	782.9	617.7
6	March'23	912.3	658.3	912.3	658.3	912.3	658.3
Six Month Average		684.8	549.7	683.1	549.6	682.7	682.7

Sl. No.	Month	Mines face Bench		Ore storage & Loading Point		Waste Dump	
		Max	Min	Max	Min	Max	Min
1.	Oct'22	548.9	451.9	548.9	454.8	545.6	452.1
2.	Nov'22	538.6	456.5	545.9	453.1	542.7	464.3
3.	Dec'23	627.8	537.9	628.0	538.0	627.5	535.2

4.	Jan'23	674.7	583	677.8	584.9	677.3	589.9
5.	Feb'23	784.8	614.8	784.7	618.3	790.6	617
6	March'23	912.3	658.3	912.3	658.3	912.3	658.3
Six Month Average		681.2	550.4	682.9	551.2	682.7	552.8

4. ILLUMINATION MONITORING (Lux)

	October 22		November 22		December 22	
LOCATION	**Horizontal**	**Vertical**	**Horizontal**	**Vertical**	**Horizontal**	**Vertical**
Workshop Area	180	70	115	58	120	62
Screen Plant	86	42	31	42	34	62
Haul Road	53	49	75	80	32	75
Loading Point	102	65	100	45	49	62
Crusher Plant	87	49	90	62	46	60
Parking Yard	60	46	42	53	69	23
Permanent Path	33	51	27	28	21	57
Electric Substation	134	75	70	77	112	77
Rest Shelter	79	50	82	47	46	56
Mines Bench Foot Path	124	98	15	41	54	46
	Jan 23		**Feb 23**		**March23**	
LOCATION	**Horizontal**	**Vertical**	**Horizontal**	**Vertical**	**Horizontal**	**Vertical**
Workshop Area	138.3	57.3	113.3	53.3	132	67.7
Screen Plant	58.2	17.1	62.2	38.1	53	49
Haul Road	58.9	46.7	47.9	55.7	102	65
Loading Point	73.2	54.5	130.2	74.5	87	49
Crusher Plant	62.5	39.3	117.5	158.3	60	46
Parking Yard	57.1	13.8	61.1	49.8	33	51
Permanent Path	40.8	32.7	24.8	22.7	46	60
Electric Substation	140.2	62.2	120.2	83.2	69	23
Rest Shelter	42.2	39.2	145.2	63.2	21	57
Mines Bench Foot Path	31.3	19.2	40.3	55.2	52	77

5. Noise Level {dB(A)}

A. Ambient Noise Monitoring

Location	October-22		November-22		December-22		Standards	
	Leq Day	Leq Night	Leq Day	Leq Night	Leq Day	Leq Night	Leq Day	Leq Night
EAST BOUNDARY	69.6	66.5	71.2	61.3	70.3	58.5	75 dB(A)	70 dB(A)
WEST BOUNDARY	72.4	67.6	74.6	65.2	72.8	62.1	75 dB(A)	70 dB(A)
NORTH BOUNDARY	68.1	64.4	67.9	60.6	68.1	56.3	75 dB(A)	70 dB(A)
SOUTH BOUNDARY	70.7	69.6	72.3	65.8	70.6	60.3	75 dB(A)	70 dB(A)
Location	**January-23**		**February-23**		**March 23**		**Standards**	
	Leq Day	Leq Night	Leq Day	Leq Night	Leq Day	Leq Night	Leq Day	Leq Night
EAST BOUNDARY	71.5	63.4	72.5	64.4	69.8	65.4	75 dB(A)	70 dB(A)
WEST BOUNDARY	71.7	65.9	72.7	66.9	71.1	62.6	75 dB(A)	70 dB(A)
NORTH BOUNDARY	69.4	58.6	68.4	59.6	64.2	55.4	75 dB(A)	70 dB(A)
SOUTH BOUNDARY	68.8	61.2	67.8	62.2	69.4	63.1	75 dB(A)	70 dB(A)

B. Source Noise Monitoring

CORE ZONE	October-22				November-22			
-	Week-1	Week-2	Week-3	Week-4	Week-1	Week-2	Week-3	Week-4
-	Leq				Leq			
Magazine Area	70.9	72.2	68.6	70.5	72.2	72.3	69.2	68.9
Drilling Machine	72.5	72.3	68.5	70.9	68.3	71.7	71.2	71.9
Mines Face/Bench	72.4	69.4	70.3	72.1	72.7	70.9	68.9	69
Haulage Road	71.5	71.1	68.3	69.3	71.1	69.5	72.9	69.6
Workshop Area	72.4	71.7	68.6	69.6	70.4	69.4	69.4	69.3
Ore Crusher Plant	71.4	69.9	72.3	72.6	71.3	68.1	70.6	69.6
Mobile Screen Plant	69.4	72.5	68.3	71.7	69.9	71.5	71.5	72.5
Ore Storage And Loading Point	70.3	68.5	70.5	69.9	71.5	71.8	71.3	71.7
Waste Dump	70.6	72.7	69.6	68.2	70.7	68.6	71.4	72.1
Excavator	71.7	70.5	69.1	73.1	70	72.7	72.6	69.2
Dozer	70.8	73.6	70.2	71.7	68.7	71.8	69.2	71.6
Dumper	72.7	68.1	68.6	68.3	71.6	72.8	69.2	70.4
Loader	68.1	71.8	72.3	68.8	69.8	71.8	68.8	70.3
DG Set	70.5	72.3	69.5	69.2	71.2	69.7	69.5	69.7
Mine Office	69.1	70.4	70.5	68.4	69.3	70.1	68.1	71.5

NUAGAON IRON ORE MINE

CORE ZONE	December-22				January-23			
-	Week-1	Week-2	Week-3	Week-4	Week-1	Week-2	Week-3	Week-4
-	Leq				Leq			
Magazine Area	72.5	69.8	72.3	70.2	71.5	70.5	71.3	71.4
Drilling Machine	69.7	70.6	70.7	71.1	70.1	71.9	72.4	70.6
Mines Face/Bench	69.2	71.9	71.8	68.3	69.6	70.4	70.7	69.8
Haulage Road	69.5	70.7	71.7	70.6	68.4	71.2	70.6	71.7
Workshop Area	70.3	71.1	72.6	72.5	71.2	70.3	71.1	70.1
Ore Crusher Plant	70.4	70.9	68.9	72.6	70.5	73.7	72.2	72.2
Mobile Screen Plant	68.9	71.4	72.1	71.3	69.7	72.5	71.5	72.6
Ore Storage And Loading Point	71	69.7	68.3	72.5	70.1	73.6	69.8	71.9
Waste Dump	71.1	68.8	71.4	70.9	69.8	69.8	68.6	69.8
Excavator	70.1	69	69.4	71.4	71.3	68.3	68.4	68.1
Dozer	70.7	69.5	72.5	68.5	71.5	68	71.5	69.5
Dumper	69.7	70.5	69.7	69.5	70.1	71.4	70.6	70.4
Loader	70.8	72.1	72.1	72.4	71.6	72.7	71.1	70.2
DG Set	72.2	70.3	68.7	70.5	73.5	73.5	72.7	72.6
Mine Office	68.8	71.7	68.6	68.2	69.7	72.2	69.2	69.4

CORE ZONE	February-23				March 23			
-	Week-1	Week-2	Week-3	Week-4	Week-1	Week-2	Week-3	Week-4
-	Leq				Leq			
Magazine Area	70.5	72.5	70.3	72.4	69.8	72.3	68.9	72.2
Drilling Machine	71.1	73.9	71.4	71.6	70.6	71.7	71.9	68.3
Mines Face/Bench	68.6	72.4	71.7	68.8	71.9	70.9	69	72.7
Haulage Road	69.4	71.2	72.6	70.7	70.7	69.5	69.6	71.1
Workshop Area	70.2	72.3	70.1	71.1	71.1	69.4	69.3	70.4
Ore Crusher Plant	71.5	71.7	71.2	71.2	70.9	68.1	69.6	71.3
Mobile Screen Plant	68.7	72.5	70.5	73.6	71.4	71.5	72.5	69.9
Ore Storage And Loading Point	71.1	73.6	70.8	70.9	69.7	71.8	71.7	71.5
Waste Dump	68.8	69.8	69.6	68.8	71.4	68.6	72.1	70.7
Excavator	70.3	68.3	69.4	69.1	69.4	72.7	69.2	70
Dozer	69.5	70	70.5	70.5	72.5	71.8	71.6	68.7
Dumper	71.1	71.4	71.6	71.4	69.7	72.8	70.4	71.6
Loader	70.6	72.7	72.1	72.2	72.1	71.8	70.3	69.8
DG Set	72.5	71.5	71.7	73.6	68.7	69.7	69.7	71.2
Mine Office	68.7	72.2	70.2	68.4	68.6	70.1	71.5	69.3

6. Surface Water Quality

NUAGAON IRON ORE MINE

Topadihi Nala Upstream

Parameter	Units	October-22	November-22	December-22	January-23	February-23	March-23	Limits for Stream Water Standards
PH	-	6.5	6.45	6.56	6.23	6.31	6.52	6.5-8.5
Total Dissolved Solids	mg/l	148	155	138	162	164	152	1500
Chlorides	mg/l	22	24	22	20	20	21	600
Iron	mg/l	0.12	0.1	0.1	0.12	0.12	0.1	50
Fluorides	mg/l	0.15	0.19	0.15	0.15	0.13	0.18	1.5
BOD	mg/l	2.2	2.9	2.2	2.3	2.6	2.1	3
DO	mg/l	5.5	5.9	5.5	6.2	6	6.2	4

Topadihi Nala Downstream

Parameter	Units	October-22	November-22	December-22	January-23	February-23	March-23	Limits for Stream Water Standards
PH	-	7.25	7.01	7.09	7.13	7.26	7.02	6.5-8.5
Total Dissolved Solids	mg/l	168	191	168	210	218	170	1500
Chlorides	mg/l	28	28	34	24	22	24	600
Iron	mg/l	0.13	0.16	0.13	0.13	0.17	0.12	50
Fluorides	mg/l	0.25	0.12	0.25	0.16	0.16	0.20	1.5
BOD	mg/l	14	4.5	10	4.9	5.2	2.5	3
DO	mg/l	5	5.2	5	5.4	5.6	5.2	4

Karo Nala Upstream

Parameter	Units	October-22	November-22	December-22	January-23	February-23	March -23	Limits for Stream Water Standards
PH	-	7	7.09	7.11	7.19	7.28	7.12	6.5-8.5
Total Dissolved Solids	mg/l	126	146	106	132	138	142	1500
Chlorides	mg/l	14	10	14	14	12	13	600
Iron	mg/l	0.14	0.11	0.14	0.14	0.17	0.15	50
Fluorides	mg/l	0.22	0.29	0.22	0.33	0.35	0.23	1.5
BOD	mg/l	2.5	2	2.5	2.5	2.4	2.6	3
DO	mg/l	6	6.3	6	6	6.2	6.1	4

Karo Nala Downstream								
Parameter	**Units**	**October-22**	**November-22**	**December-22**	**January-23**	**February-23**	**March - 23**	**Limits for Stream Water Standards**
PH	-	7.2	7.29	7.34	7.43	7.34	7.24	6.5-8.5
Total Dissolved Solids	**mg/l**	162	187	162	209	214	218	1500
Chlorides	**mg/l**	16	18	16	24	28	22	600
Iron	**mg/l**	0.17	0.19	0.17	0.14	0.18	0.20	50
Fluorides	**mg/l**	0.21	0.31	0.21	0.37	0.37	0.28	1.5
BOD	**mg/l**	6.8	4	6.8	4.9	5.6	3.2	3
DO	**mg/l**	6.4	6	6.4	5.8	5.2	5.8	4
Teherai Nala Upstream								
Parameter	**Units**	**October-22**	**November-22**	**December-22**	**January-23**	**February-23**	**March - 23**	**Limits for Stream Water Standards**
PH	-	6.85	6.77	6.91	6.37	6.43	6.78	6.5-8.5
Total Dissolved Solids	**mg/l**	108	127	118	144	152	156	1500
Chlorides	**mg/l**	26	20	26	24	26	24	600
Iron	**mg/l**	0.18	0.12	0.18	0.11	0.12	0.14	50
Fluorides	**mg/l**	0.21	0.23	0.21	0.2	0.22	0.24	1.5
BOD	**mg/l**	4.8	5	4.9	3.5	3.2	3.1	3
DO	**mg/l**	5.4	5.7	5.2	5.7	5.8	5.9	4
Teherai Nala Downstream								
Parameter	**Units**	**October-22**	**November-22**	**December-22**	**January-23**	**February-23**	**March - 23**	**Limits for Stream Water Standards**
PH	-	7.4	6.83	7.33	6.67	6.49	6.45	6.5-8.5
Total Dissolved Solids	**mg/l**	140	138	143	145	158	165	1500
Chlorides	**mg/l**	52	34	34	30	28	24	600
Iron	**mg/l**	0.23	0.16	0.23	0.14	0.19	0.18	50
Fluorides	**mg/l**	0.3	0.31	0.3	0.25	0.24	0.20	1.5
BOD	**mg/l**	14	7	12	5.6	6	3.4	3
DO	**mg/l**	5.2	5.4	5	5.6	5.2	6.2	4

Kakarpani Nala Upstream

Parameter	Units	October-22	November-22	December-22	January-23	February-23	March - 23	Limits for Stream Water Standards
PH	-	6.8	6.41	6.87	6.46	6.41	6.7	6.5-8.5
Total Dissolved Solids	mg/l	108	137	128	154	158	154	1500
Chlorides	mg/l	20	16	24	22	22	15	600
Iron	mg/l	0.11	0.25	0.11	0.22	0.24	0.14	50
Fluorides	mg/l	0.24	0.23	0.24	0.24	0.25	0.24	1.5
BOD	mg/l	7.8	2	7.2	2.6	2.6	3.1	3
DO	mg/l	5.4	6.2	5.9	6	6.2	5.8	4

Kakarpani Nala Downstream

Parameter	Units	October-22	November-22	December-22	January-23	February-23	March - 23	Limits for Stream Water Standards
PH	-	7.1	7.1	7.16	7.44	7.38	7.32	6.5-8.5
Total Dissolved Solids	mg/l	152	187	159	197	192	165	1500
Chlorides	mg/l	22	28	22	26	22	21	600
Iron	mg/l	0.1	0.23	0.1	0.2	0.23	0.12	50
Fluorides	mg/l	0.21	0.21	0.21	0.24	0.26	0.26	1.5
BOD	mg/l	10	8	9	6.5	6.8	2.6	3
DO	mg/l	5.1	5.8	5.1	5.5	5.3	5.8	4

Sona River Upstream

Parameter	Units	October-22	November-22	December-22	January-23	February-23	March - 23	Limits for Stream Water Standards
PH	-	6.87	6.93	6.77	6.76	6.72	6.43	6.5-8.5
Total Dissolved Solids	mg/l	122	157	133	166	162	146	1500
Chlorides	mg/l	18	24	18	20	22	23	600
Iron	mg/l	0.19	0.14	0.19	0.17	0.15	0.17	50
Fluorides	mg/l	0.12	0.4	0.12	0.38	0.36	0.12	1.5
BOD	mg/l	5	5.5	4	5.3	4.8	3.8	3
DO	mg/l	6.1	6.1	6.8	6	6	5.9	4

Sona River Downstream								
Parameter	**Units**	**October-22**	**November-22**	**December-22**	**January-23**	**February-23**	**March - 23**	**Limits for Stream Water Standards**
PH	**-**	7.28	7.17	7.23	7.21	7.26	7.23	6.5-8.5
Total Dissolved Solids	**mg/l**	144	203	156	233	240	232	1500
Chlorides	**mg/l**	26	28	28	24	22	24	600
Iron	**mg/l**	0.18	0.19	0.18	0.15	0.18	0.14	50
Fluorides	**mg/l**	0.22	0.41	0.22	0.36	0.36	0.26	1.5
BOD	**mg/l**	12	7	7	7.5	7.8	4	3
DO	**mg/l**	6	5.6	5.8	5.3	5	6.9	4

7. Surface Water Flow Rate

LOCATION NAME	**October-22**	**November-22**	**December-22**	**January-23**	**February-23**	**March - 23**
Karo Nala	0.69	0.44	0.51	0.41	0.61	0.64
Teherai Nala	0.42	0.42	0.51	0.54	0.54	0.57
Kakarpani Nala	0.54	0.49	0.58	0.82	0.67	0.75
Suna Nala	0.75	0.55	0.58	0.61	0.79	0.64
Topadihi Nala	0.58	0.4	0.42	0.58	0.43	0.48

8. Ground Water Quality

Location		**Rengelabeda Village**	**Nuangaon Village**	**Barpada Village**	**Katesahi Village**	**Malda Village**	**Guali Village**	**Panduliposhi Village**
Parameter	**Units**	**November-22**						
pH	-	7.25	6.9	6.72	7.15	6.89	6.73	6.96
Total Dissolved Solids as TDS	mg/l	151	130	113	160	112	132	119
Total Hardness as CaCO3	mg/l	60	40	52	64	48	52	56
Sulfate as SO4	mg/l	19.2	8.2	12.1	15.3	13.2	8.97	19.3
Chloride as Cl	mg/l	14	8	14	18	14	12	18
Fluorides as F	mg/l	0.2	0.13	0.19	0.33	0.23	0.11	0.17
Iron as Fe	mg/l	0.11	0.09	BDL	0.12	0.2	0.07	0.09

9. Drinking Water Quality

Parameter	**Units**	**October 22**	**November 22**	**December 22**	**January 23**	**February 23**	**March - 23**	**Acceptable Limits**	**Permissible Limits**

pH	-	6.89	6.93	6.85	7.15	7.18	6.8	**6.5-8.5**	**No Relaxation**
Total Dissolved Solids as TDS	mg/l	156	161	165	177	172	192	**200**	**600**
Total Hardness as CaCO3	mg/l	64	56	68	56	54	48	**1**	**No Relaxation**
Sulfate as SO4	mg/l	17.3	14.5	12.5	18.9	18.5	16.7	**250**	**1000**
Chloride as Cl	mg/l	14	10	14	14	12	14	**500**	**2000**
Fluorides as F	mg/l	0.29	0.34	0.3	0.3	0.3	0.32	**200**	**400**
Iron as Fe	mg/l	0.11	0.16	0.17	0.13	0.11	0.15	**1**	**1.5**

10. ETP

Parameter	Units	October 22	November-22	December-22	January-23	February-23	March - 23	Acceptable Limits
ETP Inlet								
pH	-	6.25	6.56	6.64	6.67	6.58	6.4	**6.5-9.0**
Total Suspended Solid as TSS	mg/l	49	56.3	65	52.8	58.6	57.8	**100.0**
Total Dissolved Solids as TDS	mg/l	377	389	423	413	424	372	**-**
Biochemical Oxygen Demand as BOD 3days at 27^0C	mg/l	32	33	35	34	36	34	**30.0**
Chemical Oxygen Demand as COD	mg/l	272	278	284	286	292	275	**250.0**
Oil & Grease as O & G	mg/l	7.11	7.8	7.23	7.3	7.2	7.2	**10.0**
Parameter	**Units**	**October 22**	**November-22**	**December-22**	**January-23**	**February-23**	**March - 23**	**Acceptable Limits**
ETP Outlet								
pH	-	6.88	6.8	6.67	6.74	6.81	6.72	**6.5-9.0**
Total Suspended Solid as TSS	mg/l	28.3	20.1	28.9	17.8	18	20.2	**100.0**
Total Dissolved Solids as TDS	mg/l	526	502	521	534	540	554	**-**
Biochemical Oxygen Demand as BOD 3days at 27^0C	mg/l	18	15	17	17	14.8	16.6	**30.0**
Chemical Oxygen Demand as COD	mg/l	120	104	120	118	116	114	**250.0**
Oil & Grease as O & G	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	**10.0**

11. Vibration Monitoring

Sl no.	Station Name	Instrument location	Season (Summer/Winter/Monsoon/post monsoon	Peak particle velocity	Air Over pressure	Frequency	Remark
1	Sonu kocha bench-6	Chenagoda road	Autumn	1.61mm/s	118.3Dbl @6.5Hz/.0005KPa	13.1Hz	Permisible Limit
2	Bench-7(sonu kochi)	Kanhusahi quarry	Autumn	1.4 mm/s	108.0dbll@14.2Hz/.005 KPa	5.5Hz	Permisible Limit
3	MDH Quarry bench-2	MDH Quarry FB Road	winter	3.19 mm/s	117.5dbl@36.5Hz/.015kpa	4.2Hz	Permisible Limit
4	Chenagoda bench-6	Near time office	winter	18.7 mm/s	128.2dbl@8.6Hz/.0512kpa	6.9Hz	Permisible Limit
5	Chenagoda	Time office canteen	winter	3.19 mm/s	117.5dbl@36.5Hz/015kpa	4.2Hz	Permisible Limit

12. Soil Monitoring

Sl. No.	Parameters	Unit	Malda Village	Katesahi Village	Barpada Village	Pamduliposhi Village	Rengalbed Village	Loidapada Village	D Top	Mine Office
1.	pH	-	5.2	5.79	5.98	5.16	5.81	6.15	8.09	7.38
2.	Electrical Conductivity	µmhos/cm	51	74	82	94	79	99	114	62
3.	Total Soluble Solid	mg/kg	98	165	172	147	165	156	145	121
4.	Nitrogen (N)	mg/kg	255	120.5	291	143	142	234	207.2	165
5.	Av. Phosphorous (P_2O_5)	kg/ha	32	19.8	39.9	23.5	38	36.3	22.9	25.1
6.	Av. Potassium (K_2O)	mg/kg	136	182	118	166	233	145	168	169
7.	Av. Sodium (Na_2O)	mg/kg	201	122	209	123	174	98	92.7	101
8.	Av. Calcium as Ca	mg/kg	1040	404	1402	704	914	628	568	748
9.	Av .Magnesium as Mg	mg/kg	344	204	280	304	288	216	240	188
10.	Chloride (Cl)	mg/kg	32	34	44	50	48	28	38	36
11.	Copper (Cu)	mg/kg	0.59	1.16	0.21	0.21	0.87	2.3	0.12	0.26
12.	Zinc (Zn)	mg/kg	0.22	0.19	0.02	0.21	0.27	0.51	0.17	0.44
13.	Iron (Fe)	mg/kg	19.49	30.08	4.27	8.9	29.33	29.33	6.35	7.49
14.	Manganese (Mn)	mg/kg	50.12	111.57	2.33	14	44.38	34.2	0.74	3.12
15.	Organic Carbon	%	0.33	0.21	0.26	0.27	0.36	0.18	0.23	0.23
16.	Sodium Absorption ratio (SAR)	-	0.5	0.45	0.48	0.35	0.47	0.31	0.3	0.31
a	Textural Class	-	Sandy Loam	Clay Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
b	Sand	%	62	60	64	58	54	56	52	60
c	Silt	%	30	30	20	24	31	24	28	26
d	Clay	%	8	10	16	18	15	20	20	14

Verified By

Vikaskumar

Technical Manager

Authorized By

Reena

Quality Manager

----End of Report----

Ecomen Laboratories Pvt. Ltd.
Second Floor Hall, House No. B-1/8,
Sector-H, Aliganj, Lucknow-226024

Road sweeping machine

Fixed water sprinkler

50 KL water tanker

16 KL water tanker

Wheel washing

Parking Plaza

Chapter 12

Recommendations for Sustainable Mining

The Central Government, in the Ministry of Mines, vide Notification No.S.O.2817 (E) dated 22nd November, 2010 had appointed a Commission of Inquiry consisting Justice M.B. Shah, retired Judge of the Supreme Court of India, for the purpose of making an inquiry into mining of iron ore and manganese ore in contravention of the provision of various Statues and the rules and regulations issued there under, in various States including the State of Odisha.

In view of Justice Shah Commission report (2013), the Ministry of Environment, Forest and Climate Change (MoEF&CC) desired to conduct a Carrying Capacity Study with an objective to develop (i) a sustainable development plan for mining activities in the impact area of about 1000 sq.km. in the State of Odisha and (ii) an environmental management plan for current as well as future developmental scenario.

Keeping in view the study objectives, CSIR-NEERI conducted the study encomassing collection of primary data for various environmental components (viz. air, noise, water, soil/ land, biological and socio-economic aspects), collection and analysis of environmental quality data by different mines in the region, modelling for transport scenario and infrastructure need assessment, and meetings/workshops with different stakeholders (like Department of Steel & Mines, Directorate of Mines, IBM-HQ & Regional Office, SPCB, GSI, MoEF&CC, State Forest Dept. etc. as well as senior executives from respective mines).

Based on the study conducted by CSIR-NEERI and analysis of inputs received from various Govt. departments and mine lease holders, the following recommendations are made:

Overall responsibility for implementation of all the recommendations shall be of State Government of Odisha through Department of Steel & Mines and other concerned State Govt. departments, viz. State Pollution Control Board, State Forest Department, District Administration etc. along with individual mine lease holders. Department of Steel & Mines shall be the nodal agency to coordinate with other concerned departments.

Financial arrangement: In the overall interest of the people of the region, the expenditure towards the implementation of various recommendations (common infrastructure and road/rail network development should be borne from District Mineral Funds being collected from different mines in the region by the Dept. of Steel & Mines, Govt. of Odisha, whereas expenditure towards recommendations applicable to individual mines shall be borne by individual mine lease holders.

The expenditure towards various regional development schemes by District Mineral Foundations (DMFs) should be in accordance with the Pradhan Mantri Khanij Kshetra Kalyan Yojna (PMKKKY), notified by Ministry of Mines, Govt. of India, vide letter no. 16/7/2017-M.VI (Part), dated September 16, 2015. Further, any other statute notified by Central/State Govt. in this regard shall also be followed.

12.1 Environmental Carrying Capacity Indicator (EC Capacity V/s Actual Production)

Availability of total reserves, annual production and estimation of additional resources in the working mines in the study region for last 10 years (during 2006-07 to 2015-16) indicated that during the last 10 years period, total 715.5 MT of iron ore were produced, whereas 1037.1 MT new resources were identified. Thus adding a total of 321.6 MT in the resources, and more resources can be estimated with additional exploration. Annual iron ore production has been in the range of 53.3 MT in 2014-15 to 81.582 MT in 2015-16, whereas, earlier maximum production of 80 MT was observed during 2009-10.

At present, total EC capacity of working 57 mines is 160.310 MTPA, whereas the actual production was 51.124 MT (32%) during 2014-15 and 81.582 MT (50.9%) during 2015-16.

Further, total production during 2016-17 was 102.663 MT (64.0%), whereas total permitted dispatch was 120.116 MT (74.9%).

Looking into the mining practices in Odisha region, it is found that Environmental Carrying Capacity can be better co-related with actual production rate rather than EC Capacity.

Therefore, State Govt. should prepare 5 years regional plan for annual iron ore requirement from the state, which in turn shall be met from different mines/zones (e.g. Joda, Koira..) in the state. Accordingly, sustainable annual production (SAP) for each zone/mine may be followed adopting necessary environmental protection measures (as suggested in **Sub-Sections 12.4, 12.5 & 12.6**). It will not have any bearing on the grant of EC.

Responsibility: Department of Steel & Mines, Govt. of Odisha

12.2 Applicability of Environmental Carrying Capacity

12.2.1 Manganese Ore Mines

Out of total 57 working iron ore and manganese mines, total EC capacity of Mn ore mines (13 exclusive Mn mines and 7 associated with iron ore) is only 1.604 million tons, whereas total production during 2014-15 and 2015-16 was only 0.357 million tons (22.2%) in each year. Therefore, further expansion or opening of new manganese ore mines may be considered only when the actual production of about 80% is achieved.

Further, the mines that have not produced Mn ore for last two years, and have no commitment in the current year as well; EC capacity in such cases may be reviewed. The Department of Steel & Mines, Govt. of Odisha shall submit the Annual Report on this issue to the MoEF&CC for further necessary action.

12.2.2 Iron Ore Mines

In view of very limited Mn ore mining activity in the study region, environmental carrying capacity shall mainly be applicable for iron ore mining activities in the study region of Joda, Koira and Baripada blocks. Daitari block of Jajpur district is included for the completeness of iron ore mining in the Odisha state.

12.2.2.1 **Daitari, Jajpur District**

Out of 57 working mines, the only mine at Daitari, Jajpur district (OMC Mine – 3 MTPA) is far away from Joda-Koira area (more than 150 km), hence is being excluded from the present analysis.

Further, expansion of this mine, and new mines in Jajpur district can be considered with proper EIA study (as per the provisions of the EIA Notification 2006, as amended from time to time) of individual mine, upto total 11 MT by 2021.

Regional carrying capacity study may be required, if more number of mines are likely to come up in the Daitari region/Jajpur district.

12.2.2.2 **Baripada/Rairangpur, Mayurbhanj District**

Out of the 3 working mines at Rairangpur/ Baripada Sector; two mines, GS Mishra & Sons, Gorumahisani and Lal Traders Agencies, Badampahar have EC capacity of 0.75 MTPA and 0.72 MTPA and use public railway sidings located in the close proximity of the mine for ore transport. Third mine of S.A. Karim is very small (1.157 ha), and is producing only about 10,000 tons of iron ore per year (EC capacity - 18000 TPA).

Therefore, these 3 mines in Mayurbhanj district are excluded, and further expansion of these mines and new mines in Mayurbhanj district can be considered with proper EIA study (as per the provisions of the EIA Notification 2006, as amended from time to time), upto 10 MT by 2021.

12.2.2.3 Joda Sector (Keonjhar District) and Koira Sector (Sundargarh District)

In view of limited iron ore mining activity in Mayurbhanj and Jajpur districts, the major iron ore producing areas that need special attention are Joda-Barbil (Keonjhar district) and Koira Sector (Sundargarh district).

At present, Joda-Barbil Sector has total 27 working mines (22 iron ore mines and 5 exclusive Mn ore mines) and Koira Sector has total 26 mines (18 iron ore mines and 8 exclusive Mn ore mines). Thus, the total iron ore mines (including 7 Mn ore associated mines) in Joda-Koira Sector are 40 only.

The total EC Capacity of these 40 mines is 155.519 MT, whereas actual production was 48.087 MT (30.9%) during 2014-15 and 77.907 MT (50.1%) during 2015-16. Total production from Joda and Koira region during 2016-17 was 98.38 MT (63.3%), whereas total permitted dispatch was 115.541 MT (74.3%).

Joda-Barbil, Keonjhar District

At present total EC Capacity of 22 iron ore mines in Joda-Barbil Sector is 106.631 MT, whereas actual production during 2014-15 was 34.420 MT (32.3%) and 55.318 MT (51.9%) during 2015-16.

Total production from Joda region during 2016-17 was 70.291 MT (65.9%), whereas total permitted dispatch was 79.575 MT (74.6%).

Koira Sector, Sundargarh District

At present total EC Capacity of 18 iron ore mines in Koira Sector is 49.209 MT, whereas actual production during 2014-15 was 13.667 MT (27.8%) and 22.589 MT (45.9%) during 2015-16.

Total production from Koira region during 2016-17 was 28.089 MT (57.0%), whereas total permitted dispatch was 35.966 MT (73.1%).

12.3 Continuation of Iron Ore Mining Activity

Analysis of baseline environmental quality data for the year 2014 and 2016 indicates that existing mining activities appear to have little / no potential impact on environmental quality, except on air environment, which was mainly due to re-suspension of road dust. Therefore, all the working mines can continue to operate with strict compliance to monitoring of environmental quality parameters as per EC and CTE/CTO conditions of the respective mine, and implementation of suggested measures for control of road dust and air pollution, as given in **Sections 4.6.2, Section 4.7 and Section 10.7**.

Odisha State Pollution Control Board has to ensure the compliance of CTE/CTO. Regional office of the MoEF&CC, Bhubaneswar shall monitor the compliance of the EC conditions. Regional office of the Indian Bureau of Mines (IBM) shall monitor the compliance of mining plan and progressive mine closure plan. Any violation by mine lease holder may invite actions per the provisions of applicable acts.

12.4 Suggested Sustainable Annual Production (SAP)

Considering the existing environmental quality, EC capacity, production rate, iron ore resources availability and transport infrastructure availability, the share of Joda and Koira sector works out to be 70% and 30% respectively for the existing scenario for the year 2015-16. However, for additional EC capacity, it can be 50:50 subject to commensurate infrastructure improvement (viz. SOTM, pollution free road transport, enhancement of rail network etc.) in the respective regions.

Accordingly, year-wise sustainable annual production from Joda and Koira area and jointly for both the regions upto 2020-21 is estimated to be as given in **Table 12.1**, **12.2** and **12.3** respectively.

Table 12.1: Actual/Suggested Sustainable Annual Production in Joda Sector (Keonjhar District) up to 2020-21

Sr. No.	Year	Horizon	Actual/Suggested Sustainable Annual Production (MT)	Mine Source with EC Capacity
1.	2015-16	Base Year	56	Total 22 iron ore mines in Joda Sector with total EC Capacity of 106.6 MTPA (already permitted/ working mines)
2.	2016-17	Ist Year	66 (56+10) (Actual production – 70.291 MT)	Existing 22 iron ore mines upto March 2016 (EC Capacity 106.6 MTPA) or Additional 10 MT from further expansion or new mines
3.	2017-18	2nd Year	76 (66+10)	Existing iron ore mines upto March 2017 or Additional 10 MT from further expansion or new mines
4.	2018-19	3rd Year	86 (76+10)	Existing iron ore mines upto March 2018 or Additional 10 MT from further expansion or new mines
5.	2019-20	4th Year	96 (86+10)	Existing iron ore mines upto March 2019 or Additional 10 MT from further expansion or new mines
6.	2020-21	5th Year	106 (96+10)	Existing iron ore mines upto March 2020 or Additional 10 MT from further expansion or new mines

Table 12.2: Actual/Suggested Sustainable Annual Production in Koira Sector (Sundargarh District) up to 2020-21

Sr. No.	Year	Horizon	Actual / Suggested Sustainable Annual Production (MT)	Mine Source with EC Capacity
1.	2015-16	Base Year	24	Total 18 existing iron ore mines in Koira Sector with total EC Capacity of 49.2 MTPA (already permitted/ working mines)

2.	2016-17	1st Year	34 (24+10) (Actual production – 28.089 MT)	Existing iron ore mines upto March 2016 or Additional 10 MT from further expansion or new mines
3.	2017-18	2nd Year	44 (34+10)	Existing iron ore mines upto March 2017 or Additional 10 MT from further expansion or new mines
4.	2018-19	3rd Year	54 (44+10)	Existing iron ore mines upto March 2018 or Additional 10 MT from further expansion or new mines
5.	2019-20	4th Year	64 (54+10)	Existing iron ore mines upto March 2019 or Additional 10 MT from further expansion or new mines
6.	2020-21	5th Year	74 (64+10)	Existing iron ore mines upto March 2020 or Additional 10 MT from further expansion or new mines

Table 12.3: Actual/Suggested Sustainable Annual Production in Joda-Koira Sector (Keonjhar & Sundargarh districts) up to 2020-21

Sr. No.	Year	Horizon	Actual / Suggested Sustainable Annual Production (MT)	Mine Source with EC Capacity
1.	2015-16	Base Year	80	Total 40 iron ore mines in Joda-Koira Sector (Keonjhar and Sundargarh districts) with total EC Capacity of 156 MTPA (already permitted/ working mines)
2.	2016-17	1st Year	100 (80+20) (Actual production – 98.38 MT)	Existing 40 iron ore mines upto March 2016 (EC Capacity 156 MTPA) or Additional 20 MT from further expansion or new mines
3.	2017-18	2nd Year	120 (100+20)	Existing iron ore mines upto March 2017 or Additional 20 MT from further expansion or new mines
4.	2018-19	3rd Year	140 (120+20)	Existing iron ore mines upto March 2018 or Additional 20 MT from further expansion or new mines
5.	2019-20	4th Year	160 (140+20)	Existing iron ore mines upto March 2019 or Additional 20 MT from further expansion or new mines
6.	2020-21	5th Year	180 (160+20)	Existing iron ore mines upto March 2020 or Additional 20 MT from further expansion or new mines

Accordingly, by 2021, the total iron production capacity can be 201 MT (Joda Sector - 106 MT; Koira Sector 74 MT, Baripada Sector - 10 MT and Jajpur Sector - 11 MT), as summarized in **Table 12.4**. However, the capacity enhancement will be subject to certain pre-requisites as listed in next point (**Section 12.5**).

Table 12.4: Summary of Suggested Sustainable Annual Production in Odisha State upto 2020-21

Sr. No.	Year	Horizon	Suggested Sustainable Annual Production (MT)				
			Joda, Keonjhar	Koira, Sundargarh	Baripada, Mayurbhanj	Daitari, Jajpur	Total (approx.)
1.	2015-16	Base year	56	24	2	3	85
2.	2016-17	1st Year	66	34	2	3	105*
3.	2017-18	2nd Year	76	44	4	5	129
4.	2018-19	3rd Year	86	54	6	7	153
5.	2019-20	4th Year	96	64	8	9	177
6.	2020-21	5th Year	106	74	10	11	201

The values are rounded off.

* Actual total production during 2016-17 was 102.7 MT, whereas total dispatch was about 120 MT. Total EC capacity is 160.31 MTPA.

Note: It is emphasized again and envisaged that preparation of 5 years regional annual plan for iron ore requirement/demand based on approved mining plan by Govt. of Odisha through Department of Steel & Mines shall streamline the iron and manganese ore mining activities in the region.

It is to be noted that as per the National Steel Policy (May 8, 2017 Notification), it is projected that total installed crude steel capacity will be about 300 MT by 2030-31, wherein total requirement of iron ore will be about 437 MT (or say 450 MT, depending on steel making route chosen).

In the draft steel policy (Page 9), it was mentioned that steel requirement will be about 144 MT by 2020-21, about 236 MT by 2025-26, and about 300 MT by 2030-31. Considering iron ore requirement of 1.5 MT per MT of crude steel, the corresponding iron ore requirement works out to be about 216 by 2020-21, 354 MT by 2025-26 and 450 MT by 2030-31 for the entire country.

In the present study on sustainable iron ore mining in Odisha State, 201 MT is suggested as sustainable annual production from Odisha by 2020-21, which is approximately 93% of the total requirement of the whole country by 2020-21; however such a mining rate is subject to certain pre-requisites, as given in the next section.

However, in case, the demand for iron ore from the State exceeds the suggested annual production by 2021, a feasibility study involving environmental sustainability considerations should be conducted.

12.5 Pre-requisites for Implementation of Suggested Sustainable Annual Production

12.5.1 Continuous monitoring of different environmental quality parameters as per EC and CTE/CTO conditions with respect to air, noise, water (surface & ground water) and soil quality in each region shall be done. The environmental quality parameters should not indicate any adverse impact on the environment. Monitoring within the mines should be done by individual mine lease holders, whereas outside the mine lease area, monitoring should be done by the Govt. of Odisha through various concerned departments/ authorized agencies. Various monitoring/ studies should be conducted through national reputed institutes, NABET/ MoEF&CC accredited laboratories/organizations.

The reports submitted by individual mine lease holders and study reports prepared by other concerned departments/agency for each of the regions should be evaluated and examined by SPCB/ MoEF&CC.

12.5.2 Construction of cement concrete road from mine entrance and exit to the main road with proper drainage system and green belt development along the roads and also construction of road minimum 300 m inside the mine should be done. This should be done within one year for existing mines and new mine should have since beginning. The concerned departments should extend full support; wherever the land does not belong to the respective mine lease holders.

The Department of Steel & Mines, Govt. of Odisha should ensure the compliance and should not issue the Mining Permits, if mine lease holder has not constructed proper cement concrete road as suggested above.

12.5.3 In view of high dust pollution and noise generation due to road transport, it is proposed to regulate/guide the movement of iron and manganese ore material based on the EC capacity of the mines. Accordingly, ore transport mode has been suggested, as given below in **Table 12.5**.

Table 12.5: EC Capacity based Suggested Ore Transport Mode (SOTM)

Code	EC Capacity	Suggested Ore Transport Mode
SOTM 1	≥ 5 MTPA	100% by private railway siding or conveyor belt up to public railway siding or pipeline for captive mines and 70% for non-captive mines
SOTM 2	Between 3 and <5 MTPA	Minimum 70% by public railway siding, through conveyor belt and maximum 30% by road - direct to destination or other public railway siding or above option
SOTM 3	Between 1 and < 3 MTPA	Minimum 70% by public railway siding and maximum 30% by road - direct to destination or by other public railway siding or above options
SOTM 4	<1 MTPA	100 % by 10/17 Ton Trucks or above options

It is mentioned by State Govt. of Odisha that currently about 45% of the iron ore is despatched using rail network and progressively it will be increased to about 60% by rail/slurry over a period of 5 years, taking into account time required to set up more railway sidings.

In view of present ore transport practices and practical limitations, all the existing mines should ensure adoption of SOTM within next 5 years.

New mines or mines seeking expansion should incorporate provision of SOTM in the beginning itself, and should have system in place within next 5 years.

However, the State Govt. of Odisha shall ensure dust free roads in mining areas wherever the road transportation of mineral is involved. The road shoulders shall be paved with fence besides compliance with IRC guidelines. All the roads should have proper drainage system and apart from paving of entire carriage width the remaining right of way should have native plantation (dust capturing species). Further, regular maintenance should also be ensured by the Govt. of Odisha.

Transportation of iron & manganese ore through river (jetty) to nearest Sea port (Sea cargo option) may be explored or connecting Sea ports with Railway network from the mines to be improved further so that burden on existing road and rail network and also pollution thereof can be minimized.

Progress on development of dust free roads, implementation of SOTM, increased use of existing rail network, development of additional railway network/conveyor belt/ pipelines etc. shall be submitted periodically to MoEF&CC.

Responsibility : Department of Steel & Mines, Govt. of Odisha

Time Period: 5 Years for developing railway/ conveyor belt facilities

12.5.4 Development of parking plazas for trucks with proper basic amenities/ facilities should be done inside mine as suggested in **Fig. 12.1**. This should be done within one year for existing mines and new mines should have since beginning.

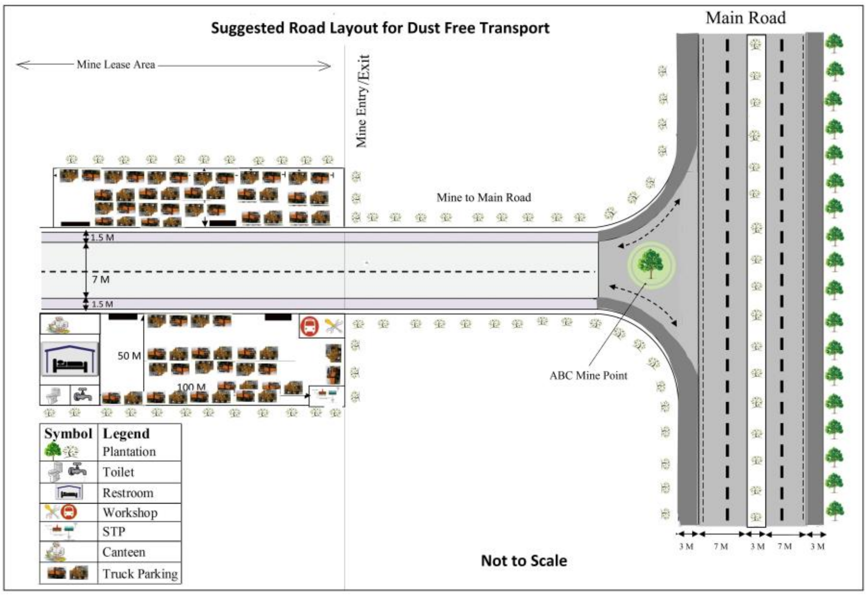


Fig. 12.1: Schematic Diagram of Suggested Parking Plazas Inside the Mining Lease Area with Connectivity to Main Road from Mine to Main Road

Small capacity mines (in terms of lease area or production) not having enough space within the mine lease areas should develop parking plaza at a common place within the region with requisite facilities.

Responsibility: Individual Mine Lease Holders

Time Period: 1 Year

12.5.5 Construction of NH 215 as minimum 4 lane road with proper drainage system and plantation and subsequent regular maintenance of the road as per IRC guidelines. Construction of other mineral carrying roads with proper width and drainage system along with road side plantation to be carried out.

Responsibility: Department of Steel & Mines with PWD / NHAI

Time Period: 2 Years

12.5.6 Regular vacuum cleaning of all mineral carrying roads aiming at "Zero Dust Re-suspension" may be considered.

Responsibility: PWD / NHAI/ Mine Lease Holders

Time Period: 3 months for existing roads

12.5.7 Expansion of existing mines and new mines should be considered after conducting recent EIA Study (as per the provisions of EIA Notification 2006, as amended time to time) with proper justification on demand scenario for iron ore requirement and availability of pollution free transport network in the region.

Responsibility: IBM, Department of Steel & Mines and MoEF&CC, New Delhi

12.6 Mine-wise Allocation of Annual Production

In case the total requirement of iron ore exceeds the suggested limit for that year, permission for annual production by an individual mine may be decided depending on approved EC capacity (for total actual dispatch) and actual production rate of individual mine during last year or any other criteria set by the State Govt., i.e. Dept. of Steel & Mines.

Department of Steel and Mines in consultation with Indian Bureau of Mines-RO should prepare in advance mine-wise annual production scenario as suggested in **Table 12.6**, so that demand for iron ore can be anticipated, and actual production/dispatch does not exceed the suggested annual production.

Table 12.6: Allocation of Production to Different Mines for 5 Years (as per approved Mining Plan)

Mine Lease	EC Capacity (MTPA)	Suggested Annual Production (MT)				
		2016-17	2017-18	2018-19	2019-20	2020-21
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Mine 1	X1					
Mine 2	X2					
Mine 3	X3					
Mine n	Xn					
Total	160 + dX	105	129	153	177	201

Next year allocation = Average of EC Capacity and Last year production

12.7 Expansion of Existing Mines having Validity up to 2020

In view of implementation of MMDR Act 2015, wherein many non-captive mines are expected to be closed by March 2020, total iron ore production scenario has been prepared (**Section 2.4.7**). It is expected that the non-captive mines having validity till 2020 shall try to maximize their production (limited to EC capacity) in the remaining period. Further, depending upon availability of iron ore resources, these mines may also seek expansion of EC capacity.

It may be noted here that total EC capacity of existing 25 working mines having validity upto 2020 is about 85 MTPA, whereas actual production from these mines has been only 44.677 MT (52.6%) during 2015-16 and 57.07 MT (67.1%) during 2016-17. Also, it is expected that these mines would not even be able to achieve ore production as per existing EC capacity till March 2020. Therefore, these existing mines should go for production to the fullest extent to meet the requisite demand from the State. However, where EC limit is exhausted, application for expansion may be considered.

Further, the EC process (i.e. Grant of TOR, Baseline data collection, Mining plan/ scheme approval, Public hearing, preparation of EIA/EMP Report, Appraisal by the EAC and grant of EC) takes about one year time. Under such circumstances, it is suggested that further applications for grant of TOR or grant of EC for expansion of production capacity of the mine should be considered for those existing mines, which have exhausted their capacity subject to consideration of all environmental aspects.

Responsibility: Department of Steel & Mines and MoEF&CC, New Delhi

12.8 Sustained Iron Ore Production beyond 2020

12.8.1 Considering the implementation of MMDR Act 2015, total production of iron ore in Odisha State is anticipated to be about 111 MT during 2016-17 (actual production was – 102.663 MT), 136 MT during 2017-18, 146 MT during 2018-19 and 146 MT during 2019-20. Then there will be substantial drop in total production (to the tune of 73 MT during 2020-21 onwards) due to closure of mines, which are valid up to 2020 (**Section 2.4.7**).

Therefore, in order to maintain operation/sustained growth of downstream industries, iron ore mining in the region needs to be continued at a sustainable rate. The State Govt. through Department of Steel and Mines should initiate appropriate action to ensure continued availability of iron ore from the region, as per suggested sustainable annual production (**Section 12.2** and **Section 12.4**).

12.8.2 Reserves Estimation – Mining Plan and Exploration

Appropriate actions (geo-technical investigation for qualitative and quantitative resource estimation & other preparations for auction of mines), may be initiated taken into account the existing working mines, and the mines which were operational at some point of time (but closed presently due to various reasons).

The total iron ore reserves/ resources available within the total lease area of each mine should be estimated by State Govt./NMET/ GSI (or any other approved agency) with respect to:

- Total lease area of mine (surface)
- Maximum depth to which resources could be available
- Resources below the ground water table (if intersected)
- Reserves are to be estimated as per UNFC code with respect to quantity and quality (% Fe content)
- Maximum mining rate and area for auction (after 2020) will be calculated based on total resources available and proposed life of mine leading to closure of mine in a stipulated time period

  Responsibility: Department of Steel & Mines, IBM and GSI

  Time frame: 1 year for the mines to be auctioned for next 2 years

  The above mentioned organizations shall ensure the compliance with respect to timelines for implementations.

12.8.3 Depending upon availability of extractable iron ore resources within a mine, mining below the ground water table may be permitted after conducting necessary geological and hydro-geological study by GSI and requisite approval from the CGWB/CGWA (Central Ground Water Board/Authority). This can be explored at least in few mines on trial/pilot basis.

Further, within a mine, it will be desirable to operate one pit at a time, and next pit should be opened after extracting maximum possible resources from the first pit, so that the exhausted pit can be used for back filling/ storing of low grade iron ore. However, depending upon the quantity and/or quality of iron/ manganese ore, other mine pits in the same mine lease may also be opened for sustainable scientific mining, as per approved mining plan/scheme of mining by IBM.

The Department of Steel & Mines, Govt. of Odisha should initiate the pilot project so that minerals are fully utilized.

12.8.4 Commercial Utilization of Low Grade Ore

R&D studies towards utilization of low-grade iron ore should be conducted through research/academic institutes like IMMT, Bhubaneswar, NML, Jamshedpur, and concerned metallurgical departments in IITs, NITs etc., targeting full utilization of low-grade iron ore (Fe content upto 45% by 2020 and upto 40% by 2025). In fact, life cycle assessment of whole process including environmental considerations should be done for techno-economic and environmental viability.

R&D studies on utilization of mine wastewater having high concentration of Fe content for different commercial applications in industries such as cosmetics, pharmaceutical, paint industry should also be explored.

Responsibility: IBM, Dept. of Steel & Mines, Individual Mine Lease Holders

12.8.5 The mining activity in Joda-Koira sector is expected to continue for another 100 years, therefore, it will be desirable to develop proper rail network in the region. Rail transport shall not only be pollution free mode but also will be much economical option for iron ore transport. The rail network and/or conveyor belt system upto public railway siding needs to be created as detailed in **Section 10.6.1**. The total length of the conveyor belt system/ rail network to be developed from mines to nearest railway sidings by 11 mines in Joda region is estimated to be about 64 km. Similarly, in Koira region, total length of rail network/ conveyor system for 8 mines (under SOTM 1 & 2) is estimated to be around 95 km. Further, it is suggested to develop a rail network connecting Banspani (Joda region) and Roxy railway sidings in Koira region, as shown in **Fig. 12.2**.

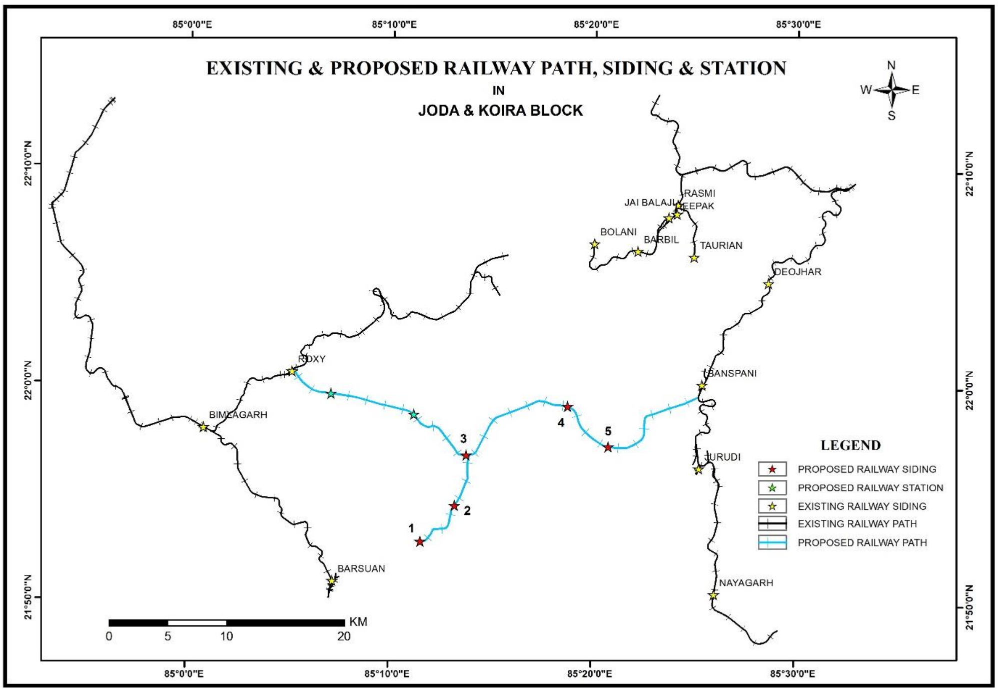


Fig. 12.2: Existing (Black in colour) and Proposed Rail Network (Blue in colour) Connecting Banspani and Roxy Railway Sidings

Responsibility: Dept. of Steel & Mines, Govt. of Odisha and Concerned Mines along with Indian Railways

Time Period: Maximum 7 years (by 2025)

The Department of Steel & Mines, Govt. of Odisha should follow-up with the concerned Departments and railways so that proposed proper rail network is in place by 2025.

12.8.6 State Govt. of Odisha shall make all efforts to ensure exhausting all the iron & manganese ore resources in the existing working mines and from disturbed mining leases/zones in Joda and Koira region. The criteria suggested in **Section 12.8.2** shall be applicable while suggesting appropriate lease area and sustainable mining rate.

Responsibility: Dept. of Steel & Mines, Govt. of Odisha

12.8.7 Large and medium mine leases contribute to better implementation of reclamation and rehabilitation plans to sustain the ecology for scientific and sustainable mining. The small leases do not possess scientific capability of environmentally sustainable mining. Therefore, new mine leases having more than 50 ha area should be encouraged, as far as possible. This will ensure inter-generational resource availability to some extent.

Responsibility: Dept. of Steel & Mines, Govt. of Odisha

12.8.8 Further, regional carrying capacity study must be conducted for each of the regions (Joda, Koira & Bripada) on a regular interval of 5 years to ensure adoption of sustainable mining practices with expected/committed societal development in the region.

Responsibility: Department of Steel & Mines and MoEF&CC, New Delhi.

Environmental Protection Measures

12.9 Mining Operations/Process Related

12.9.1 Appropriate mining process and machinery (viz. right capacity, fuel efficient) should be selected to carry out various mining operations that generate minimal dust/air pollution, noise, wastewater and solid waste. e.g. drills should either be operated with dust extractors or equipped with water injection system.

12.9.2 After commencement of mining operation, a study should be conducted to assess and quantify emission load generation (in terms of air pollution, noise, waste water and solid waste) from each of the mining activity (including transportation) on annual basis. Efforts should be made to further eliminate/ minimize generation of air pollution/dust, noise, wastewater, solid waste generation in successive years through use of better technology. This shall be ensured by the respective mine lease holders.

12.9.3 Various machineries/equipment selected (viz. dumpers, excavators, crushers, screen plants etc.) and transport means should have optimum fuel/power consumption, and their fuel/power consumption should be recorded on monthly basis. Further, inspection and maintenance of all the machineries/ equipment/ transport vehicles should be followed as per manufacturer's instructions/ recommended time schedule and record should be maintained by the respective mine lease holders.

12.9.4 Digital processing of the entire lease area using remote sensing technique should be carried out regularly once in 3 years for monitoring land use pattern and mining activity taken place. Further, the extent of pit area excavated should also be demarcated based on remote sensing analysis.

This should be done by ORSAC (Odisha Space Applications Centre, Bhubaneswar) or an agency of national repute or if done by a private agency, the report shall be vetted/ authenticated by ORSAC, Bhubaneswar. Expenses towards the same shall be borne by the respective mine lease holders.

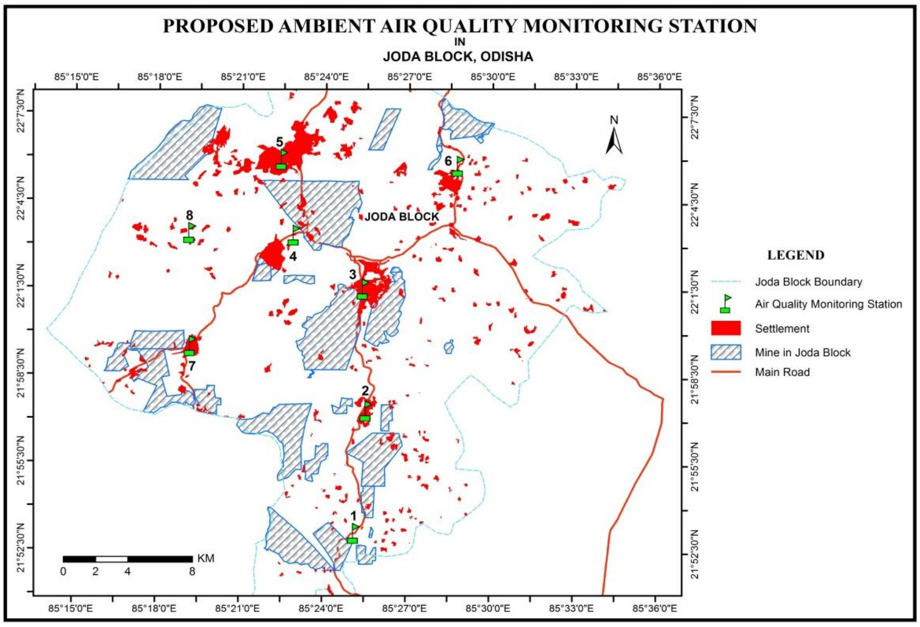
Responsibility: Individual Mine Lease Holders

12.10 Air Environment Related

12.10.1 Fugitive dust emissions from all the sources should be controlled regularly on daily basis. Water spraying arrangement on haul roads, loading and unloading and at other transfer points should be provided and properly maintained. Further, it will be desirable to use water fogging system to minimize water consumption. It should be ensured that the ambient air quality parameters conform to the norms prescribed by the CPCB in this regard.

12.10.2 The core zone of mining activity should be monitored on daily basis. Minimum four ambient air quality monitoring stations should be established in the core zone for SPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and CO monitoring. Location of air quality monitoring stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets and frequency of monitoring should be undertaken in consultation with the State Pollution Control Board (based on Emission Load Assessment Study). The number of monitoring locations may be more for larger capacity mines and working in larger area. Out of four stations, one should be online monitoring station in the mines having more than 3 MTPA EC Capacity.

12.10.3 Monitoring in buffer zone should be carried out by SPCB or through NABET accredited agency. In addition, air quality parameters (SPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and CO) shall be regularly monitored at locations of nearest human habitation including schools and other public amenities located nearest to source of the dust generation as applicable. Further, 11 continuous air quality monitoring systems may be installed in Joida and Koira regions and one in Baripada/ Rairangpur region as suggested in **Section 10.7,** and shown in **Fig. 12.3**.



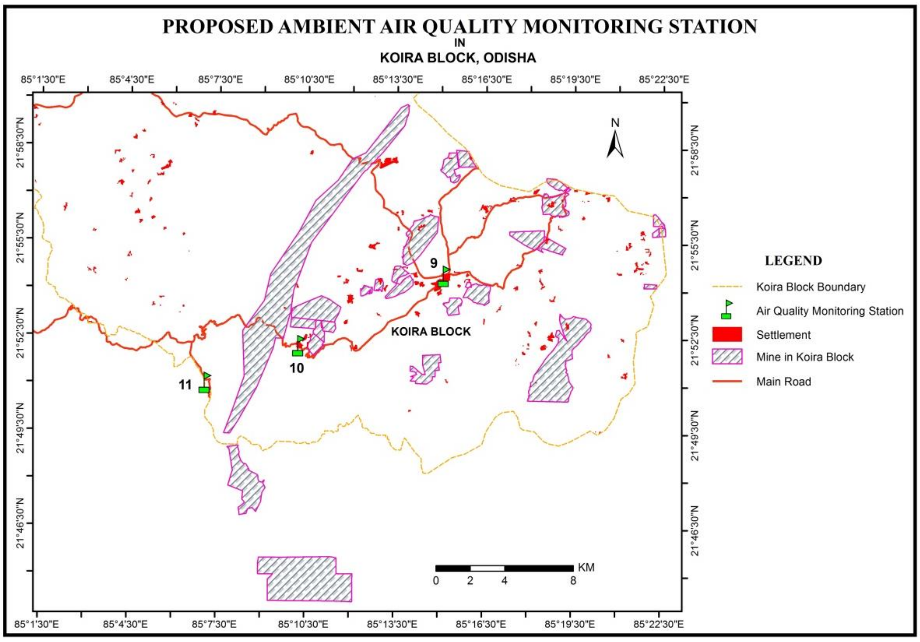


Fig. 12.3: Suggested Online Air Quality Monitoring Stations in Joda and Koira Regions (Outside the Mine Lease Areas)

12.10.4 Emissions from vehicles as well as heavy machinery should be kept under control and regularly monitored. Measures should be taken for regular maintenance of vehicles used in mining operations and in transportation of mineral.

The vehicles shall be covered with a tarpaulin and should not be overloaded.

Further, possibility of using closed container trucks should be explored for direct to destination movement of iron ore.

Air quality monitoring at one location should also be carried out along the transport route within the mine (periodically, near truck entry and exit gate).

Responsibility: Individual Mine Lease Holders and SPCB

12.11 Noise and Vibration Related

12.11.1 Blasting operation should be carried out only during daytime. Controlled blasting such as Nonel, should be practiced. The mitigation measures for control of ground vibrations and to arrest fly rocks and boulders should be implemented.

12.11.2 Appropriate measures (detailed in Section 5.4) should be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in operations of HEMM, etc. should be provided with ear plugs/muffs.

12.11.3 Noise levels should be monitored regularly (on weekly basis) near the major sources of noise generation within the core zone. Further, date, time and distance of measurement should also be indicated with the noise levels in the report. The data should be used to map the noise generation from different activities and efforts should be made to maintain the noise levels with the acceptable limits of CPCB (CPCB, 2000).

12.11.4 Similarly, vibration at various sensitive locations should be monitored atleast once in month, and mapped for any significant changes due to successive mining operations.

Responsibility: Individual Mine Lease Holders

12.12 Water/Wastewater Related

12.12.1 In general, the mining operations should be restricted to above ground water table and it should not intersect groundwater table. However, if enough resources are estimated below the ground water table, the same may be explored after conducting detailed geological studies by GSI and hydro-geological studies by CGWB or NIH or institute of national repute, and ensuring that no damage to the land stability/ water aquifer system shall happen. The details/ outcome of such study may be reflected/incorporated in the EIA/EMP report of the mine appropriately.

12.12.2 Natural watercourse and/or water resources should not be obstructed due to any mining operations. Regular monitoring of the flow rate of the springs and perennial nallas should be carried out and records should be maintained. Further, regular monitoring of water quality of nallas and river passing thorough the mine lease area (upstream and downstream locations) should be carried out on monthly basis.

12.12.3 Regular monitoring of ground water level and its quality should be carried out within the mine lease area by establishing a network of existing wells and constructing new piezometers during the mining operation. The monitoring should be carried out on monthly basis.

12.12.4 In order to optimize water requirement, suitable conservation measures to augment ground water resources in the area should be undertaken in consultation with Central Ground Water Board (CGWB).

12.12.5 Suitable rainwater harvesting measures on long term basis should be planned and implemented in consultation with CGWB, to recharge the ground water source. Further, CGWB can prepare a comprehensive plan for the whole region.

12.12.6 Appropriate mitigation measures (viz. ETP, STP, garland drains, retaining walls, collection of runoff etc.) should be taken to prevent pollution of nearby river/other water bodies. Water quality monitoring study should be conducted by State Pollution Control Board to ensure quality of surface and ground water sources on regular basis. The study can be conducted through NABL/ NABET approved water testing laboratory. However, the report should be vetted by SPCB.

12.12.7 Industrial wastewater (workshop and wastewater from the mine) should be properly collected, treated in ETP so as to conform to the discharge standards applicable.

Oil and grease trap should be installed before discharge of workshop effluents. Further, sewage treatment plant should be installed for the employees/colony, wherever applicable.

12.12.8 Mine lease holder should ensure that no silt originating due to mining activity is transported in the surface water course or any other water body. Appropriate measures for prevention and control of soil erosion and management of silt should be undertaken. Quantity of silt/soil generated should be measured on regular basis for its better utilization.

Erosion from dumps site should be protected by providing geo-textile matting or other suitable material, and thick plantation of native trees and shrubs should be carried out at the dump slopes. Further, dumps should be protected by retaining walls.

12.12.9 Trenches / garland drain should be constructed at the foot of dumps to arrest silt from being carried to water bodies. Adequate number of check dams should be constructed across seasonal/perennial nallas (if any) flowing through the mine lease areas and silt be arrested. De-silting at regular intervals should be carried out and quantity should be recorded for its better utilization, after proper soil quality analysis.

The water so collected in the reservoir within the mine should be utilized for the sprinkling on hauls roads, green belt development etc.

12.12.10 There should be zero waste water discharge from the mine. Based on actual water withdrawal and consumption/ utilization in different activities, water balance diagram should be prepared on monthly basis, and efforts should be made to optimize consumption of water per ton of ore production in successive years.

Responsibility: Individual Mine Lease Holders, SPCB and CGWB

12.13 Land/ Soil/ Overburden Related

12.13.1 The top soil should temporarily be stored at earmarked site(s) only and it should not be kept unutilized for long (not more than 3 years or as per provisions mentioned in the mine plan/ scheme). The topsoil should be used for land reclamation and plantation appropriately.

12.13.2 Fodder plots should be developed in the non-mineralised area in lieu of use of grazing land, if any.

12.13.3 Over burden/ low grade ore should be stacked at earmarked dump site(s) only and should not be kept active for long period. The dump height should be decided on case to case basis, depending on the size of mine and quantity of waste material generated. However, slope stability study should be conducted for larger heights, as per IBM approved mine plan and DGMS guidelines.

The OB dump should be scientifically vegetated with suitable native species to prevent erosion and surface run off. In critical areas, use of geo textiles should be undertaken for stabilization of the dump. Monitoring and management of rehabilitated areas should continue until the vegetation becomes self-sustaining. Proper records should be maintained regarding species, their growth, area coverage etc.

12.13.4 Catch drains and siltation ponds of appropriate size should be constructed to arrest silt and sediment flows from mine operation, soil, OB and mineral dumps. The water so collected can be utilized for watering the mine area, roads, green belt development etc. The drains should be regularly de-silted, particularly after monsoon and should be maintained properly. Appropriate documents should be maintained.

Garland drain of appropriate size, gradient and length should be constructed for mine pit, soil. OB and mineral dumps and sump capacity should be designed with appropriate safety margin based on long term rainfall data.

Sump capacity should be provided for adequate retention period to allow proper settling of silt material. Sedimentation pits should be constructed at the corners of the garland drains and de-silted at regular intervals.

12.13.5 Backfilling should be done as per approved mining plan/scheme. There should be no OB dumps outside the mine lease area. The backfilled area should be afforested, aiming to restore the normal ground level. Monitoring and management of rehabilitated areas should continue till the vegetation is established and becomes self-generating.

12.13.6 Hazardous waste such as, waste oil, lubricants, resin, and coal tar etc. should be disposed off as per provisions of Hazardous Waste Management Rules, 2016, as amended from time to time.

Responsibility: Individual Mine Lease Holders

12.14 Ecology/ Biodiversity (Flora-Fauna) Related

12.14.1 As per the Red List of IUCN (International Union for Conservation of Nature), six floral species and 21 faunal species have been reported to be under threatened, vulnerable & endangered category. Protection of these floral and faunal species should be taken by the State Forest & Wildlife Department on priority, particularly in the mining zones, if any.

12.14.2 The mines falling within 5-10 km of the Karo-Karampada Elephant corridor buffer need to take precautionary measures during mining activities. The forest and existing elephant corridor routes are to be protected and conserved. Improvement of habitat by providing food, water and space for the elephants is required to be ensured to avoid Man-Elephant conflicts.

Though as per the records of State Forest Department, movement of elephants in the Karo-Karampada elephant corridor within 10 km distance from the mines in Joda and Koira is not observed, the Forest Department shall further record and ensure that elephant's movement is not affected due to mining activities.

12.14.3 All precautionary measures should be taken during mining operation for conservation and protection of endangered fauna namely elephant, sloth bear etc. spotted in the study area. Action plan for conservation of flora and fauna should be prepared and implemented in consultation with the State Forest and Wildlife Department within the mine lease area, whereas outside the mine lease area, the same should be maintained by State Forest Department.

12.14.4 Afforestation is to be done by using local and mixed species saplings within and outside the mining lease area. The reclamation and afforestation is to be done in such a manner like exploring the growth of fruit bearing trees which will attract the fauna and thus maintaining the biodiversity of the area. As afforestation done so far is very less, forest department needs to identify adequate land and do afforestation by involving local people in a time bound manner.

12.14.5 Green belt development carried out by mines should be monitored regularly in every season and parameters like area under vegetation/plantation, type of plantation, type of tree species /grass species/scrubs etc., distance between the plants and survival rate should be recorded.

12.14.6 Green belt is an important sink of air pollutants including noise. Development of green cover in mining area will not only help reducing air and noise pollution but also will improve the ecological conditions and prevent soil erosion to a greater extent. Further, selection of tree species for green belt should constitute dust removal/dust capturing plants since plants can act as efficient biological filters removing significant amounts of particulate pollution. Thus, the identified native trees in the mine area may be encouraged for plantation. Tree species having small leaf area, dense hair on leaf surface (rough surface), deep channels on leaves should be included for plantation.

12.14.7 Vetiver plantation on inactive dumps may be encouraged as the grass species has high strength of anchoring besides medicinal value.

12.14.8 Details of compensatory afforestation done should be recorded and documented by respective forest divisions, and State Forest Department should present mine-wise annual status, along with expenditure details.

12.14.9 Similarly, Wildlife Department is also required to record and document annual status of wildlife in the region and should identify the need for wildlife management on regional level.

12.14.10 Maintenance of the ecology of the region is prime responsibility of the State Forest and Wildlife Department. They need to periodically review the status and identify the need for further improvement in the region. The required expenditure may be met from the funds already collected in the form of compensatory afforestation and wildlife management. Further, additional fund, if required can be sought from DMF.

Responsibility: Individual Mine Lease Holders and State Forest & Wildlife Department

12.15 Socio-Economic Related

12.15.1 Public interaction should be done on regular basis and social welfare activities should be done to meet the requirements of the local communities.

Further, basic amenities and infrastructure facilities like education, medical, roads, safe drinking water, sanitation, employment, skill development, training institute etc. should be developed to alleviate the quality of life of the people of the region.

12.15.2 Land outees and land losers/affected people, if any, should be compensated and rehabilitated as per the national/state policy on Resettlement and Rehabilitation.

12.15.3 The socio-economic development in the region should be focused and aligned with the guidelines/initiatives of Govt. of India/ NITI Aayog / Hon'ble Prime Minister's Vision centring around prosperity, equality, justice, cleanliness, transparency, employment, respect to women, hope etc. This can be achieved by providing adequate and quality facilities for education, medical and developing skills in the people of the region. District administration in association with mine lease holders should plan for "***Samagra Vikas***" of these blocks well as other blocks of the district.

While planning for different schemes in the region, the activities should be prioritized as per Pradhan Mantri Khanij Kshetra Kalyan Yojna (PMKKKY), notified by Ministry of Mines, Govt. of India, vide letter no. 16/7/2017-M.VI (Part), dated September 16, 2015 (Annexure II).

Responsibility: District Administration and Individual Mine Lease Holders

12.16 Road Transport Related

12.16.1 All the mine lease holders should follow the suggested ore transport mode (SOTM), based on its EC capacity within next 5 years.

12.16.2 The mine lease holders should ensure construction of cement road of appropriate width from and to the entry and exit gate of the mine, as suggested in Chapter 10. Further, maintenance of all the roads should be carried out as per the requirement to ensure dust free road transport.

12.16.3 Transportation of ore should be done by covering the trucks with tarpaulin or other suitable mechanism so that no spillage of ore/dust takes place. Further, air quality in terms of dust, PM_{10} should be monitored near the roads towards entry & exit gate on regular basis, and be maintained within the acceptable limits.

Responsibility: Individual Mine Lease Holders and Dept. of Steel & Mines

12.17 Occupational Health Related

12.17.1 Personnel working in dusty areas should wear protective respiratory devices and they should also be provided with adequate training and information on safety and health aspects periodically.

12.17.2 Occupational health surveillance program for all the employees/workers (including casual workers) should be undertaken periodically (on annual basis) to observe any changes due to exposure to dust, and corrective measures should be taken immediately, if needed.

12.17.3 Occupational health and safety measures related awareness programs including identification of work related health hazard, training on malaria eradication, HIV and health effects on exposure to mineral dust etc., should be carried out for all the workers on regular basis. A full time qualified doctor should be engaged for the purpose.

Periodic monitoring (on 6 monthly basis) for exposure to respirable minerals dust on the workers should be conducted, and record should be maintained including health record of all the workers.

Review of impact of various health measures undertaken (at an interval of 3 years or less) should be conducted followed by follow-up of actions, wherever required. Occupational health centre should be established near mine site itself.

Responsibility: Individual Mine Lease Holders and District Administration (District Medical Officer)

12.18 Reporting of Environmental Sustainability Achievement

All the mines should prepare annual environmental sustainability report (ESR), highlighting the efforts made towards environmental protection with respect to different environmental components vis-à-vis production performance of the mine on monthly basis. The data collected as per EC and CTE/CTO conditions should be utilized to prepare the annual sustainability report.

The mines performing high with effective environmental safeguards may be suitably recognized/rewarded. "Star Rating Format" formulated by the Ministry of Mines along with environmental sustainability report may be used.

12.19 Environmental Monitoring Requirements at Regional Level

Apart from strict compliance and monitoring by individual mine lease holder, there is a need for simultaneous monitoring in each of the regions by competent expert agencies under the guidance/ supervision of concerned regulatory agency. Details of the studies required to be done on regular basis (continuously for 5 years) through responsible agency (organization of national/state repute) and time frame are suggested in **Table 12.7**.

Table 12.7: Suggested Environmental Monitoring Requirements and Action Plans at Regional Level

Sr. No.	Study Component/ Action Plan	Responsibility	Monitoring and Reporting Time Frame (Approx.)
1.	Environmental Quality Monitoring with respect to Air, Water, Noise and Soil Quality in each region (Joda, Koira and Baripada/Rairangpur) as per specified frequency shall be done by a third party (preferably Govt.) and/or laboratory approved/ recognized by NABET/ CPCB/ SPCB/ MoEF&CC. All the water bodies (rivers, nallas, ponds etc.) shall be monitored. National/State level research/ academic institutes may be involved initially for couple of years to streamline the activity. The report shall be brought out annually by June each year. The study shall be conducted in consultation with MoEF&CC-RO.	SPCB	Continuous Annually
	Installation of online ambient air quality monitor for PM_{10}, $PM_{2.5}$, SOx and NOx within the mine having more than 3 MTPA EC Capacity	Respective Mine Lease Holders	Continuous Annually
	Installation of online ambient air quality monitor for PM_{10}, $PM_{2.5}$, SOx and NOx in the Joda and Koira Region (total 11 locations as suggested in **Section 12.10.3** and **Fig. 12.3**)	SPCB	Continuous Annually

2.	Status of flora and fauna in each of the regions shall be assessed on annual basis. Changes, if any, taking place in the region shall be brought out clearly. The study shall be conducted in consultation with State Forest and Wildlife Department.	State Forest & Wildlife Dept.	Annually in mining zone and once in 3 years in the region
3.	Socio-economic study incorporating developments taking place in each of the region, CSR initiatives made by the mining companies shall be conducted on annual basis. Further, micro level developmental needs shall be clearly brought out in the report for each region. The study shall be conducted in consultation with district administration.	Respective District Administration	Annually
4.	A detailed hydro-geological study in each of the regions shall be conducted in an integrated manner in consultation with Regional Director, Central Ground Water Board. Accordingly, all project proponents shall implement suitable conservation measures to augment ground water resources in the area.	SPCB	Once in 2 years
5.	The State Govt. shall ensure construction and maintenance of dust free common roads/ appropriate rail network for transport of ore from mines to the consumer end.	Dept. of Steel & Mines	12 months for road network and 5-7 years for rail network
6.	Construction and maintenance of dust free roads from respective mine to the main road	Respective Mine Lease Holders	Continuous 6 months
7.	Traffic/road inspection study addressing the condition of traffic/roads leading to different mines and connecting to different railway sidings shall be undertaken on annual basis. Further, detailed traffic study shall be undertaken on every 5 yearly basis to ensure adequacy of road/rail infrastructure in each of the regions. The study can be undertaken through national/ state level research/ academic institute (such as CSIR-CRRI, New Delhi).	Dept. of Steel & Mines	Continuous 6 months
8.	Assessment of landuse/ landcover changes in each of the regions, with particular focus on mining areas, afforestation activities, variation in flow path of various water bodies etc. using remote sensing data	ORSAC	Annually
9.	R&D Studies for utilization of low-grade iron ore	Dept. of Steel & Mines through R&D / Academic Institutes	Upto 45% by 2020 and upto 40% by 2025

The data so generated for the region should be made available on the website of Department of Steel & Mines and also at MoEF&CC website, so that it can be effectively utilized by Individual Mine Lease Holders for preparing EIA/ EMP reports. This will meet the requirement for separate one season baseline environmental quality data collection by the individual proponents, if the mine proposed is in the same study region.

Further, MoEF&CC (through EAC) can also utilize the data base available in evaluating the proposals for expansion of existing mines or new mines while granting ToR or EC to the mine, taking an holistic view of the region.

State Govt. of Odisha should bring out an integrated environmental sustainability report for each of the regions (mainly for Joda and Koia region) incorporating ESR of individual mines and data collected in the region through various agencies, once in 5 years, to plan level of scientific and sustainable mining for the next 5 years.

12.20 Institutional Mechanism for Implementation of Environmentally Sustainable Mining

The present study is not a one-time study, but a process to ensure environmentally sustainable mining activities in the region on long term basis. Looking into the large-scale mining activities and long term perspective for mining vis-à-vis environmentally sustainable mining and upliftment of people of the region, there is a need to create an agency, who will integrate all the aspects relating to sustainable mining in the region on long term basis. It could be a SPV of Govt. of Odisha or a cell within the overall control and supervision of Dept. of Steel & Mines, with members from IBM, GSI, OSPCB, MoEF&CC-RO and other concerned Departments and Mine Owners (EZMA), District Administration.

It is found that the strong database available for the region needs to be taken into account to map and establish environmental quality of the region on daily, monthly, seasonal and annual basis. Further, the efforts and initiatives of the mines towards environmental protection as well as upliftment of the people of the region are required to be integrated, and a systematic plan at the block/regional level needs to be framed for the overall benefit of the local society, region, district, state and the country as a whole.

It will be desirable to have proper environmental quality data management and analysis by NEERI or any other agency for next 5 years (six monthly compliance reports followed by field verification) ensuring sustainable mining practices in the region leading to an overall development of the region.

District Mineral Funds should be utilized appropriately for various developmental activities/needs of the region. Further, an environmental sustainability report incorporating environmental status of region coupled with social upliftment may be brought out by SPCB or any other authorized agency on annual basis. This report can be used for supporting the regional EIA study, and also need for environmental quality monitoring by individual mine seeking environmental clearance for new mine/ expansion of mine, including public hearing.

Since, outcome of the above study reports shall be in the overall interest of all the stakeholders (including local population) of the region, further planning for the region shall warrant cooperation and assistance of all the stakeholders (mine operators, industries, transporters, State & Central Governmnet Offices, MoEF&CC, CPCB, SPCB, Dept. of Steel & Mines, IBM, IMD, NGOs and local people) in sharing the relevant data/

information/ reports/documents etc. to continuosly improve upon the environmentally sustainable development plan for economic growth in mining sector as well as for improvement in quality of life of the people of the region.

At present, in order to ensure the implementation of various recommendations of the report prepared by CSIR-NEERI, it is proposed that a High Level Committee may be constituted under the Chairmanship of the Chief Secretary of the Govt. of Odisha. The composition of the committee may be as follows:

- **Chairman -** Chief Secretary, Govt. of Odisha
- **Vice-Chairman -** Principal Secretary, Dept. of Steel & Mines, Govt. of Odisha
- **Member Secretary –** Director Mines, Directorate of Mines, Govt. of Odisha
- **Members -**
    - Principal Secretary, Forest Department, Govt. of Odisha
    - Principal Secretary, Environment Department, Govt. of Odisha
    - Regional Controller of Mines, Indian Bureau of Mines, Bhubaneswar
    - Member Secretary, State Pollution Control Board, Bhubaneswar
    - Principal Chief Conservator of Forest & Wildlife - Forest Department, Bhubaneswar
    - Regional Officer – MoEF&CC, Bhubaneswar
    - Director, Department of Mines, Govt. of Odisha
    - Regional Director, Geological Survey of India, Bhubaneswar
    - Regional Director, Central Ground water Board/Authority, Bhubaneswar
    - Chief Executive, Odisha Space Applications Centre, Bhubaneswar
    - District Collectors of Respective Districts (Keonjhar & Sundargarh)
    - President, Eastern Zone Mining Association (EZMA)
    - NGOs working on Social Development Activities (one each from Joda and Koira region)
    - Opted Members from CSIR Research Institutes like NEERI, Nagpur, CIMFR, Dhanbad, IMMT, Bhubaneswar, NML, Jamshedpur, CRRI, New Delhi.

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Washing and Desliming of Iron Ore Fines of Nuagaon and Narayanposhi Mines

Submitted to

M/s. JSW Steel Ltd.
Mines Division
Odisha

Prepared by

Mineral Processing Dept.
CSIR-Institute of Minerals & Materials Technology
Bhubaneswar-751013

Foreword

I am happy to forward the report on "Washing and Desliming of Iron Ore Fines of Nuagaon and Narayanposhi Mines" prepared for M/s. JSW Steel Ltd., Mines Division, Odisha. This report includes the mineralogical, physical and chemical characteristics of two iron ore samples as well as physical beneficiation, settling and filtration studies of finer size range of particles to generate the concentrate as sinter and pellet feed material. Mineralogical, physical and chemical studies provide the valuable information to develop the conceptual process flowsheet. Suitable washing and desliming process flowsheet was developed to utilize this low grade iron ores with predominant association with clay minerals. It is possible to get concentrate having more than 62.5% Fe with around more than 82% yield and less than 2.5% alumina in combination of scrubbing, classification and beneficiation of fine range particles using high intensity magnetic separator.

I wish that these findings can be utilised by M/s. JSW Steel Ltd., Mines Division, Odisha for utilization of low grade iron ore fines.

Director
CSIR-Institute of Minerals and Materials Technology
Bhubaneswar

प्रस्तावना

मैसर्स जे.एस.डब्ल्यू स्टील लिमिटेड, खान प्रभाग, ओडिशा के लिए तैयार "नुआगांव और नारायणपोशी खानों के लौह अयस्क फाइन्स की धुलाई और डीस्लिमिंग" पर रिपोर्ट को अग्रेषित करते हुए मुझे खुशी हो रही है। । इस रिपोर्ट में दो लौह अयस्क नमूनों की खनिज, भौतिक और रासायनिक विशेषताओं के साथ-साथ भौतिक लाभकारी, कणों के महीन आकार की सीमा के निपटान और निस्पंदन अध्ययन शामिल हैं ताकि सिंटर और पेलेट फीड सामग्री के रूप में ध्यान केंद्रित किया जा सके। खनिज, भौतिक और रासायनिक अध्ययन वैचारिक प्रक्रिया फ्लोशीट विकसित करने के लिए बहुमूल्य जानकारी प्रदान करते हैं। क्ले मिनरल्स खनिजों के साथ प्रमुख सहयोग के निम्न श्रेणी के लौह अयस्कों का उपयोग करने के लिए उपयुक्त धुलाई और डीस्लिमिंग प्रक्रिया फ्लोशीट विकसित की गई। उच्च तीव्रता वाले चुंबकीय विभाजक का उपयोग करके महीन श्रेणी के कणों के स्क्रबिंग, वर्गीकरण और लाभकारी के संयोजन में लगभग 82% से अधिक उत्पादकता और 2.5% से कम एल्यूमिना के साथ 62.5% Fe से अधिक सांद्रता प्राप्त करना संभव हो पाया।

मेरी इच्छा है कि इन निष्कर्षों का उपयोग मैसर्स जेएसडब्ल्यू स्टील लिमिटेड, खान प्रभाग, ओडिशा द्वारा निम्न ग्रेड लौह अयस्क फाइन के उपयोग के लिए किया जा सकता है। ।

निदेशक

सीएसआईआर-खनिज और पदार्थ प्रौद्योगिकी संस्थान, भुवनेश्वर

Washing and Desliming of Iron Ore Fines of Nuagaon and Narayanposhi Mines

Submitted to

M/s. JSW Steel Ltd.
Mines Division
Odisha

Prepared by

CSIR-Institute of Minerals and Materials Technology
Bhubaneswar-751013, India

Foreword

I am happy to forward the report on "Washing and Desliming of Iron Ore Fines of Nuagaon and Narayanposhi Mines" prepared for M/s. JSW Steel Ltd., Mines Division, Odisha. This report includes the mineralogical, physical and chemical characteristics of two iron ore samples as well as physical beneficiation, settling and filtration studies of finer size range of particles to generate the concentrate as sinter and pellet feed material. Mineralogical, physical and chemical studies provide the valuable information to develop the conceptual process flowsheet. Suitable washing and desliming process flowsheet was developed to utilize this low grade iron ores with predominant association with clay minerals. It is possible to get concentrate having more than 62.5% Fe with around more than 82% yield and less than 2.5% alumina in combination of scrubbing, classification and beneficiation of fine range particles using high intensity magnetic separator.

I wish that these findings can be utilised by M/s. JSW Steel Ltd., Mines Division, Odisha for utilization of low grade iron ore fines.

Director
CSIR-Institute of Minerals and Materials Technology
Bhubaneswar

Executive Summary

As per the recent National Steel Policy of Govt. of India, steel production will be enhanced to 300 MTPA in 2030 from current production of 115 MTPA to increase per capita consumption from 65kg to 160kg against the world average 218kg. For the production of 300 MTPA, the country needs high-quality ore around 450 MTPA in form of calibrated ore, sinter and pellet to meet the requisite demand. To catering 450 MPTA, around 750-800 MPTA ores are to be mined.

M/s. JSW Steel Ltd. Mines Division, Odisha was interested to carry out the beneficiation studies of iron ores from their captive mines i.e., Nuagaon and Narayanposhi. CSIR-IMMT, Bhubaneswar has taken the responsibility to carry out characteristics and beneficiation studies to achieve the concentrate as sinter and pellet feed material.

The mineralogical and chemical analysis of Nuagaon iron ore mines was carried out. The Fe content in the bulk sample is 60.27%. The alumina, silica and LOI of the sample are 4.46%, 3.36% and 5.31% respectively. The Bond work index was carried out as per the standard procedure. The Bond work index of the bulk sample is 9.7 kWh/tonne. After desliming by using screw scrubber, the Bond work index was enhanced to 11.00 kWh/tonne. The desliming study of ore was carried out using screw scrubber to classify 100 micron particles as screw scrubber overflow. The water and solid ratio was maintained around 7:3. The overflow percentage with respect to feed was 40%. The Fe content of underflow of screw scrubber could be enhanced to 63.61%. The underflow of screw scrubber was also treated in gravity separation process using jig and spiral concentrator to enhance the Fe content. As grinding system is not available in this circuit, the jig and spiral concentrator tailings cannot be rejected due to high Fe content. Hence the screw scrubber underflow product was considered as one of the products. The Fe content in overflow of screw scrubber is 55.31%. The overflow was treated in magnetic separator to recover iron values from slimes. The Fe content in magnetic concentrate is 61.99%. This is the second product of the process. The overall yield of the process is 82.65% with 63.17% Fe, 1.73% Al_2O_3, 2.59% SiO_2 and 4.57% LOI.

The mineralogical and chemical analysis of Narayanposhi iron ore mines was carried out. The Fe content in the bulk sample is 60.76%. The alumina, silica and LOI of the sample are 4.16%, 2.75% and 6.18% respectively. The Bond work index was carried out as per the standard procedure. The Bond work index of the bulk sample is 11.5 kWh/tonne. After desliming by using screw scrubber, the Bond work index was enhanced to 12.40 kWh/tonne. The desliming study of ore was carried out using screw scrubber to classify 100 micron particles as screw scrubber overflow. The water and solid ratio were maintained around 7:3. The overflow percentage with respect to feed was 19.10%. The Fe content of underflow of screw scrubber could be enhanced to 62.47%. Hence it was considered as one of the products. The Fe content in overflow of screw scrubber is 53.61%. The overflow was treated in rougher and scavenger magnetic separators to recover iron values from slimes. The Fe content in rougher magnetic concentrate is 62.15% and 58.66 % Fe in scavenger magnetic concentrate. Magnetic concentrate is the second product of the process. The overall yield of the process is 91.93% with 62.32% Fe, 2.92% Al_2O_3, 1.81% SiO_2 and 5.86% LOI.

In overall study of beneficiation of screw scrubber overflow was done by magnetic separation process but in commercial plant, the hydrocyclone provision should be there to make further classification before magnetic separator in case of the low grade ore contains less than 58% Fe.

The concentrate and tailings of Nuagaon iron ore sample were taken for the settling study to provide the basic data for design of thickeners. A commercial anionic flocculent was used for settling of fine particles in the present study. The settling study of the concentrate was carried out at different solid concentration from 20 to 35% at 5% interval. The settling study of the tailings were carried out at the solid concentration of 5-10%. The pressure filtration of concentrates and the tailings were carried out using pilot scale filter press. During filter press operation, the cycle time was 22 minutes for filtration of concentrate and 35 minutes for the tailings. It is possible to achieve around 16% moisture in the filter cake for the concentrate and around 21-22% moisture for the tailings. Similarly, the settling and filtration studies of Narayanposhi iron ore sample was carried out.

Acknowledgements

Institute of Minerals and Materials Technology (IMMT), Bhubaneswar, has promoted a vision of Mineral Processing in India and abroad that lowers energy cost, reduces economic risk through improved processing, conserves resources and protects the environment. With this vision we took up to carry out research to carry out the beneficiation study of BMQ sample from M/s. JSW Steel Ltd., Mines Division, Odisha. We would like to express our sincere thanks to Mr. Ranjan Kumar Nayak, COO; Mr. James John, AVP; Mr. Swatantra Kumar, Sr. Manager; and Mr. Puneeth Rao Pawar, Manager; and also the Management of M/s. JSW Steel Ltd., Mines Division, Odisha for providing an opportunity to work on this project specially. We thank all the scientists and staff members in MP Dept. of CSIR-IMMT who have supported directly/indirectly to complete this project.

Investigators

Investigators

1. Dr. S. K. Biswal, Head & Chief Scientist, MP Department
2. Dr. A. K. Sahu, Chief Scientist
3. Dr. P. C. Beuria, Senior Principal Scientist
4. Dr. S. P. Das, Senior Principal Scientist
5. Dr. Alok Tripathy, Senior Scientist
6. Mr. S. N. Sahu, Senior Scientist & PL

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Number of Tables	: 66

Content

Chapter 1
Introduction

1.1 Background

Iron ores are valuable natural resources being finite and non-renewable. Iron ore is one of the basic raw materials for iron and steel industries. The production of iron and steel has significantly expanded in recent years, particularly in China and India. It is predicted that the steel production may reach more than 2600 million tonnes in 2030. The recycle in form of iron scrap may meet around 650 million tonnes per annum. The remaining more than 3200 million tonnes per annum will be met through fresh iron ore. This has resulted in a large increase in the demand for iron ore. The quality of iron ore deposits, however, has deteriorated worldwide because of long-term mining, and the existing mines are having increasing difficulty in producing ore with a high grade of iron ore by simple crushing and screening. It is great concern for steel industries to either receive suitable quality iron ore in form of lumpy or sinter/pellet.

Australia and Brazil are among the world's largest iron ore producers and hold a large portion of the world's iron ore reserves. India is the 4th largest iron ore producer next to Australia, Brazil and China. India produced 209 million tonne during 2019-20 financial years. As per the recent National Steel Policy of Govt. of India, steel production will be enhanced to 300 MTPA in 2030 from current production of 115 MTPA to increase per capita consumption from 65kg to 160kg against the world average 218kg. For the production of 300 MTPA, the country needs high-quality ore around 450 MTPA in form of calibrated ore, sinter and pellet to meet the requisite demand. To catering 450 MPTA, around 750-800 MPTA ores are to be mined as shown in Fig.1.1.

1.2 Status of Iron Ore in India

India has 33 billion tonnes of primary iron ore resources like hematite and magnetite based minerals. Out of this, around 10.5 billion tonnes BMQ is available in India as on 1.4.2015 as per Mineral Year Book 2018 published by IBM, Nagpur. Remaining resources comes under hematite category. India's 98% magnetite reserves/resources in form of magnetite or BMQ are located in five States, namely, Karnataka (7,802 million tonnes or 72%) followed by Andhra Pradesh (1,392 million tonnes or 13%), Rajasthan (617 million tonnes or 6%), Tamil Nadu (507 million tonnes or 5%) and Goa (226 million tonnes or 2%). Similarly, the total reserves/resources of haematitic ore as on 1.4.2015 have been estimated at 22.5 billion tonnes. Major reserves/resources of hematitic ore are located in Odisha (7,559 million tonnes or 34%), Jharkhand (5,286 million tonnes or 23%), Chhattisgarh (4,858 million tonnes or 22%), Karnataka (2,467 million tonnes or 11%) and Goa (1,189 million tonnes or 5%). The threshold value of hematite iron ore is 45% Fe whereas 35% for siliceous hematite ore available in State of Goa.

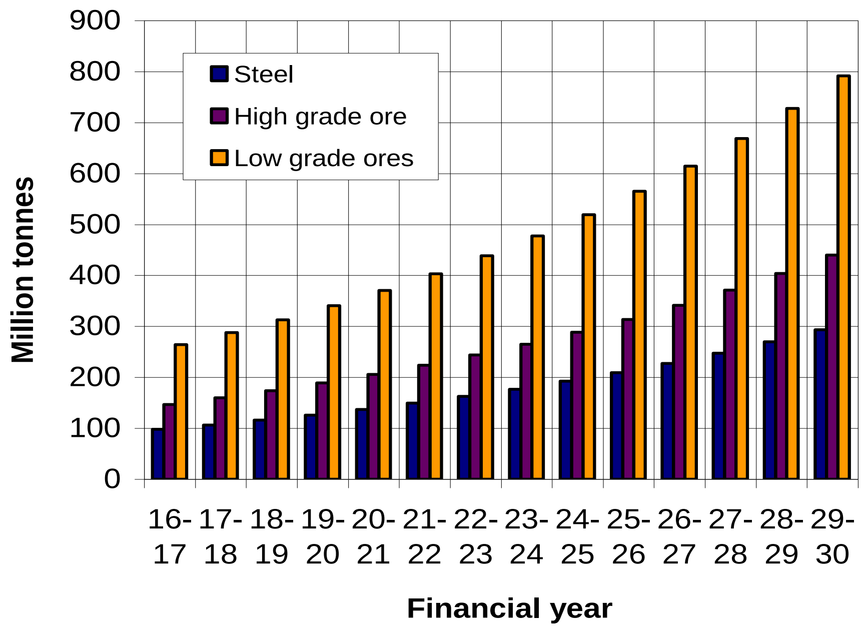

Fig. 1.1 Production of steel, high grade ores and low grade ores for beneficiation

1.3 Characteristics of Indian Ore

Indian hematitic iron ore deposits are soft and friable in nature because it is associated with goethite. During mining, it has been reported that the ratio between fines and lump ores is 2:1. Additionally, generation of fines happens due to mechanised mining and also preparation of sized ores by crushing and screening. Hence 50-70% fines (both high and low grades) are generated during mining and preparation of ore activities. The country is not endowed with high-grade requisite iron ore resources. It is, therefore, imperative to achieve the best use of available low-grade iron ore resources through scientific methods of beneficiation and pelletisation. Challenges and solutions are needed to be focussed for upgradation of Indian low-grade hematite iron ore in association of goethite, kaolinite and gibbsite minerals. The recovery of micro fines of iron phase minerals from slimes/tailings from iron ore washing/beneficiation plants should be taken seriously to maximize the utilization of these resources for long-term sustainability. Nature of iron phase minerals and associated gangue minerals decide the process flowsheet of iron ore beneficiation to be adopted. Utilization of low-grade iron ores through beneficiation and pelletisation is closely interlinked with the environmental impact on the surrounding of the mines. Both aspects have to be properly coordinated to facilitate and ensure a sustainable development of beneficiation and pelletisation processes for utilization of iron ores in harmony with the environment.

1.4 Problems and Challenges of the Indian Iron Ore

In general, Indian hematite ore contains a good amount of clay minerals, which affects the process fluid dynamics due to their swelling properties. It increases the viscosity of the slurry; hence it affects the grinding as well as separation units. These ores are more fragile in nature due to presence of goethite phase. As a result, the ultra fine generation in the grinding circuit is more and ultimately it increases the Blaine number which has negative impact in the pelletisation plant. Percentage of goethite increases when Fe content of the ore decreases and other gangues minerals increases simultaneously. As per commercial plant observation, below 55% Fe content of ore does not respond well to the conventional beneficiation process.

1.5 Present Practice

At present practice in India, the ROM ore is crushed and classified into different size fractions either in dry or wet process. Most of the mines are operated in a dry process using hard ore by selective mining to cater the calibrated iron ore need of iron and steel industries. It is crushed to below 40/30 mm or 18mm size and classified at 10 mm/5mm size to provide the suitable size of calibrated ore (40/30+10 mm) or (-18+5 mm) to blast furnace/DRI operation respectively if the ore meets requisite metallurgical, physical and chemical properties. Whatever fine ore is generated due to crushing and classification processes, it may be utilized in sintering plant of integrated steel plants if it meets the required specification. The low grade ore is subjected to the physical beneficiation to recover the iron values, otherwise, it is dumped in mine site as rom fine dumps as shown in Fig.1.2. In the same time, percentage of low-grade fines increases day-by-day due to depletion of high-grade iron ore. It also creates environmental impact in air and water body in the surrounding of the mine. Utilization of these fines is the need of hour to maximize the iron recovery through suitable beneficiation process which should hold up the economic feasibility and environmental sustainability. Some of the iron ore mining industries are still making the washing of coarse particles and putting the slimes in the pond as shown in Fig. 1.3. These slimes also contain good amount of Fe values.

Fig. 1.2 Iron ore low grade dump fines

Fig. 1.3 Iron ore slimes pond

1.6 Appropriate Approach for Iron Ore Beneficiation

- Percentage of goethite increases when Fe content of the ore decreases and simultaneously other gangues minerals increases. When the ore contains less than 55% Fe, it has been noted that goethite percentage is more than 50%. Hence this ore does not respond well to the conventional beneficiation process using gravity and magnetic separation techniques using physical properties. As the Indian hematite ore contains good amount of clay, it should be removed at the beginning of the process using scrubbing equipment like screw scrubber/screw classifier, reflux classifier or drum scrubber. Hence the effect of slimes in the grinding and separation units in the process can be minimised.

- During grinding of the ore, proper classification unit with closed circuit grinding is very indispensable to reduce the generation of ultra-fine.
- Grinding product and desliming product should be treated separately to avoid the selectivity of the particles during separation process.
- If more goethite presents in the ore or liberated goethite is more, reduction roasting process may be adopted to maximise the recovery of the iron values.

1.7 Objective of the Project

M/s. JSW Steel Ltd., Mines Division, Odisha is planning to set up Washing and Desliming Iron Ore Plant to generate concentrates for sinter and pellet feed material from 58-60% Fe from Nuagaon and Narayanposhi mines.

The scopes of the work involved in this study:

(i) Sample preparation
(ii) Size analysis of as received sample
(iii) Detail chemical analysis of as received sample
(iv) Fe analysis of each size fractions
(v) Washing study by screw scrubber
(vi) Desliming study by hydrocyclone
(vii) Detail chemical analysis of screw scrubber product, hydrocyclone underflow and overflow
(viii) Settling study of cyclone overflow and underflow
(ix) Filtration study of hydrocyclone underflow
(x) Material (solid and water) balance of process
(xi) Report preparation

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Chapter 2

Characterization, Beneficiation and Dewatering Studies of Nuagaon Sample

2.1 Introduction

Around 1 tonnes of Iron ore below 10 mm sample was received from Nuagaon Iron ore mines, Barbil, Odisha to carry out the desliming and beneficiation study to develop the suitable process flowsheet for production of high-grade iron ore concentrate. Around 100 kg representative sample was taken by standard coning and quartering method for size analysis, chemical analysis, bond work index, mineralogical studies and bulk density of bulk sample. The remaining sample was processed for desliming and beneficiation studies.

2.2 Characterisation Study

2.2.1 Size & Fe Analysis of Bulk Sample

The total sample of around 1 tonnes was thoroughly mixed and representative sample was drawn by coning and quartering method for size analysis. Then the size analysis with respective Fe analysis of bulk sample was carried out and the result is given in Table 2.1. The remaining sample was subjected to beneficiation studies.

Table 2.1
Size and Fe analysis of bulk sample

Size, mm	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
+10	3.50	3.50	63.34	63.34
+6	14.25	17.75	63.99	63.86
+3	12.65	30.40	64.18	63.99
+2	4.79	35.19	63.94	63.99
+1	9.11	44.30	63.52	63.89
+0.850	5.14	49.44	61.99	63.69
+0.500	3.80	53.24	61.71	63.55
+0.300	3.67	56.91	62.11	63.46
+0.210	4.40	61.31	61.71	63.33
+0.150	2.81	64.12	62.06	63.28
+0.100	2.03	66.15	61.15	63.21
+0.075	1.38	67.53	62.27	63.19
+0.045	3.71	71.24	61.71	63.12

-0.045	28.76	100.00	53.17	60.26
Total	100.00		60.26	
Bulk			60.27	

2.2.2 Detail Chemical Analysis

The detailed chemical analysis, LOI along with the trace elements of the bulk sample was carried out. The result is given in the Table 2.2. The major impurity is quartzite and aluminum oxide. The hematite percent in the ore is about 86.19 %.

Table 2.2
Detail chemical analysis of the bulk sample

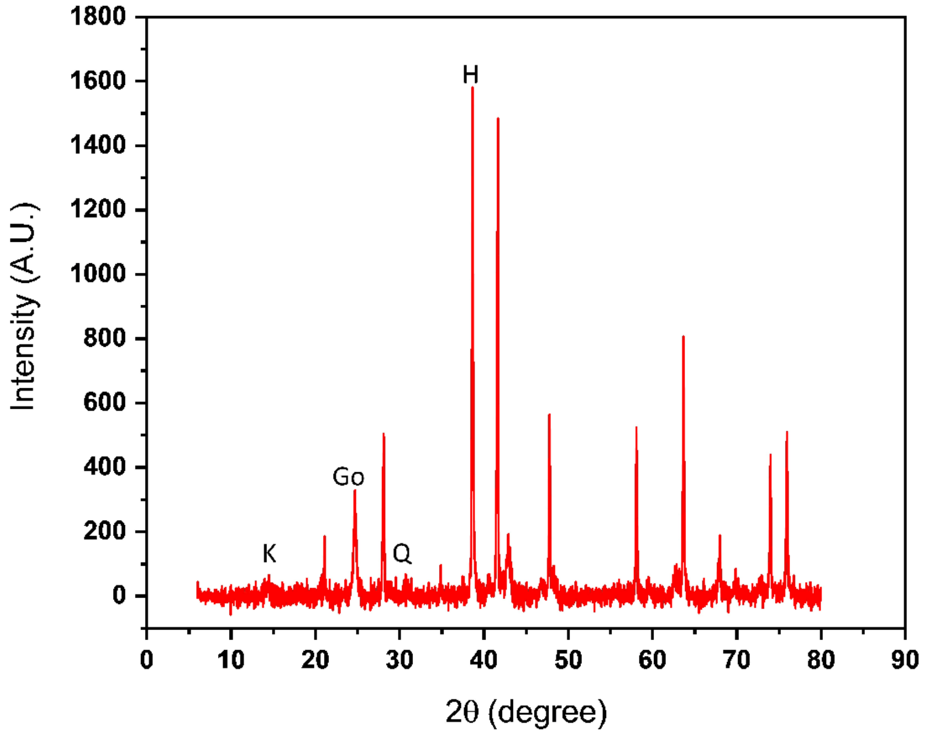
Details	Percentage
Fe (T)	60.27
Fe_2O_3	86.19
SiO_2	3.36
Al_2O_3	4.46
CaO	0.13
Cr_2O_3	0.006
CuO	0.005
K_2O	0.066
MgO	0.032
MnO_2	0.029
Na_2O	0.01
NiO	0.004
P_2O_5	0.004
PbO	0.008
TiO_2	0.126
V_2O_5	0.018
ZnO	0.014
LOI	5.31

2.3 Mineralogical Study

Mineralogical study of the bulk sample was carried out by using X-ray diffraction study. This study gives the qualitative mineralogical identification of different phases present with their textures.

2.3.1 XRD Study

XRD study was carried out on the representative bulk sample to determine the major minerals present in the sample. The XRD result is shown in Fig. 2.1 It indicates that the bulk sample have hematite as the major mineral phase and other minerals are goethite, quartz and kaolinite.



H: Hematite, Go: Goethite, Q: Quartz, K: Kaolinite

Fig. 2.1 XRD study of bulk sample

2.4 Sequential Heating Analysis of Bulk Sample

The sequential heating at different temperature was carried out using muffle furnace for bulk sample to determine the association of minerals like goethite, gibbsite, kaolinite and overall LOI content. The result of sequential heating is given in Table 2.3. Based on weight loss at different temperatures, percentage of goethite, gibbsite and kaolinite were calculated. The percentage of water loss during 108ºC to 450ºC is used to calculate the percentage of goethite and gibbsite mineral. The percentage of water loss during 450ºC 850ºC is used to calculate the percentage of kaolinite mineral. The percentage of water loss during 850ºC 950ºC is used to calculate the percentage of carbonate minerals.

Mineralogical characteristion study carried out by using both heating cycle and chemical analysis is given Table 2.4.

Table 2.3
LOI at different temperature by sequential heating cycle of bulk sample

400°C	850°C	950°C	Total LOI, %
4.11	1.15	0.05	5.31

Table 2.4
Mineralogical characteristics study by using heating cycle and chemical analysis

<table>
<tr><td rowspan="2">Heating Cycle Analysis</td><td>Hematite, %</td><td>Goethite, %</td><td>Kaolinite, %</td><td>Gibbsite, %</td></tr>
<tr><td>55.86</td><td>33.92</td><td>8.24</td><td>1.92</td></tr>
<tr><td rowspan="2">Chemical Analysis</td><td>Fe(T), %</td><td>LOI, %</td><td>Al_2O_3, %</td><td>SiO_2, %</td></tr>
<tr><td>60.27</td><td>5.31</td><td>4.46</td><td>3.36</td></tr>
</table>

2.5. Estimation of Bond Work Index

2.5.1 Sample Preparation

Around 30 kg of representative bulk sample was taken and screened at 3.36 mm size. The +3.36 mm size was crushed to below 3.36 mm size by using roll crusher. Then, it was thoroughly mixed and the representative sample was drawn for grindiability study for determination of Bond Work Index (BWI).

2.5.2 Ball Mill Grindiability Process

Grindiability study was carried out as per the standard procedure described by Bond. The Bond ball mill work index determination is carried out in a standard test mill and under standard conditions. The test mill has an internal diameter of 12 inch and length is also 12 inch. It has a smooth lining with rounded corners, no lifters except for a 4” X 8” hand hole lid for charging.

It has a revolution counter and runs at 70 rpm. The grinding charge consists of 285 iron balls weighing 20.125 kg. It consists of about 43 numbers of 1.45” balls, 67 numbers of 1.17” balls, 10 numbers of 1” balls, 71 numbers of 0.75” balls and 94 numbers 0.61” balls with a calculated surface area of 842 sq inch.

The standard feed was prepared by passing all through 3.36 mm size. It was packed by shaking in a 1000 cc graduated cylinder, and the weight of 700 cc was placed in the mill and ground dry at 250 percent circulating load. After the first grinding period of 100 revolutions, the mill was dumped; the ball charge was screened out and 700 cc of material was screened on 150 mesh (100 micron) with coarser protecting sieves if necessary. The undersize was weighed and fresh unsorted feed was added to oversize to bring its weight back to that of original charge. Then it was returned on to the balls in the mill and ground for the number of revolutions calculated from the results of the previous period to produce sieve undersize equal to 1/3.5 of the total charge in the mill. The grinding period cycles were continued until the net grams of sieve undersize produced per mill revolution reaches equilibrium and reverses its direction of increase or decrease. Then the undersize product and circulating load were screen analyzed, and the average of the last three net grams per revolution (G_{bp}) was the mill grindiability. When F is the size in microns which 80 percent of the new ball mill feed passes, P is the microns which 80 percent of the last cycle sieve undersize product passes, and P_1 is the opening in microns of sieve size tested (100 micron), then the ball mill work index W_i is calculated from the following revised equation;

$$W.\ I. = 44.5 / \{(P_i)^{0.23} \times (G_{bp})^{0.82} \times 10\ (1 / \sqrt{P} - 1/\sqrt{F})\} \qquad \textbf{(2.1)}$$

2.5.3 Bond Work Index of Bulk Sample

The representative iron ore bulk sample was taken for grindability study as per Bond's method. The size analysis of the crushed product for grindability study was carried and the results are given in the Table 2.5. It was found that d_{80} of the feed material was 1860 micron. The grindability study was carried for 100 micron test sieve. The weight of the 700 cc of material was 1630 gm. For 250 percent circulating load, 466 gm of -100 micron particles are to be produced at equilibrium revolution. To reach the equilibrium revolution a number of tests were carried out. At the equilibrium stage, G_{bp} was 2.27.

The size analysis of -100 micron product was carried out. The size analysis of product is given in the Table 2.6. The overall grindability result of bulk Sample is given in Table 2.7. The particle size distribution of feed and product is depicted in Fig. 2.2 and 2.3 respectively. The d_{80} of the ball mill product was 78.5 micron. Then according to Equation, W.I. was calculated and it was found 8.8 kWh/short ton. It was converted to normal tonne and WI value is 9.7 kWh/tonne.

$Wi = (44.5)/((P_1)^{0.23} X (Gbp)^{0.82} (10/\sqrt{P} - 10/\sqrt{F}))$

$=(44.5)/((100)^{0.23} X (2.27)^{0.82} (10/\sqrt{78.5} - 10/\sqrt{1860}))$

= 8.8 kWh/short ton

= 8.8 X 1.1 = **9.7 kWh/tonne**

The bond work index of the sample is determined to be 9.7 kWh/tonne.

Table 2.5
Feed size analysis

Size, micron	Cum. Wt., % Passing
3360	100.00
2000	83.40
1400	64.51
1000	55.85
850	48.64
500	40.71
212	33.92
150	27.97
100	23.80

Table 2.6
Size analysis of ground product

Size, micron	Cum Wt., % Passing
100	100.00
75	76.50
63	57.00
45	39.50
38	22.50

Table 2.7
Results of gram per revolution

No. of revolutions	100micron produced (g)	100micron in the feed (g)	Net -100micron produced (g)	Grindability (g/rev.)
100	632	268	364	3.640
100	458	103.9	354	3.558
110	398	75.3	323	2.937
136	414	65.4	349	2.555
156	436	68.1	368	2.361
167	452	71.7	380	2.276
172	462	74.3	388	2.252
173	471	76.0	395	2.280

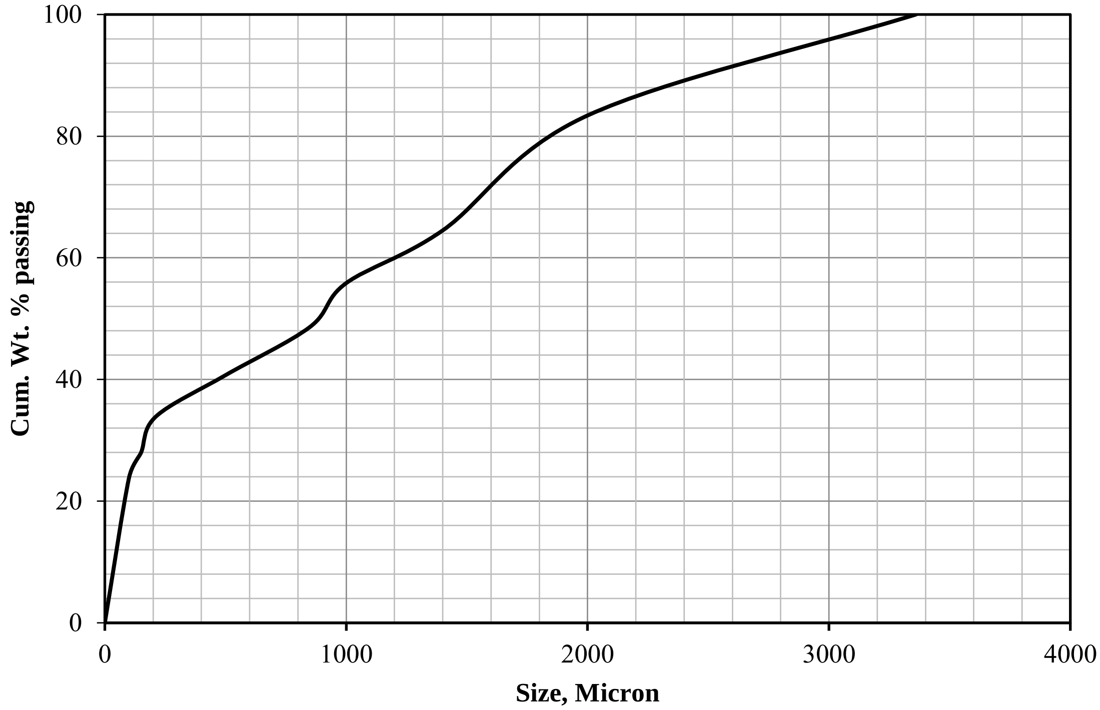


Fig. 2.2 Particle size distribution of feed

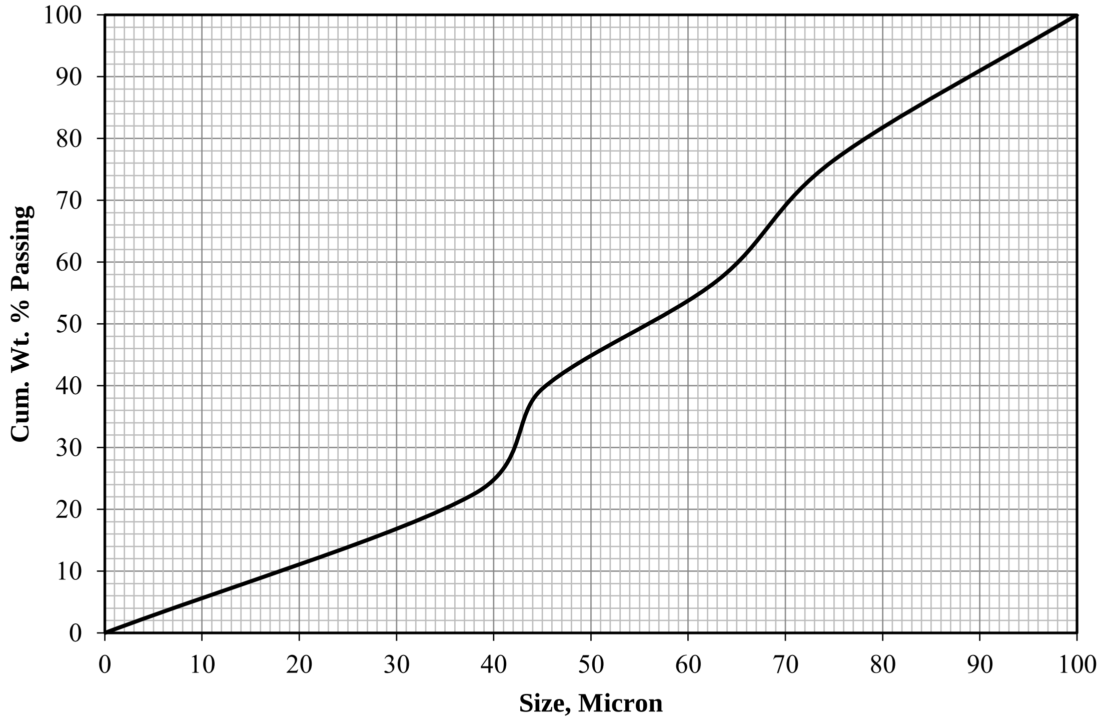


Fig. 2.3 Particle size distribution of product

2.5.4 Bond Work Index of Screw Scrubber Underflow Sample

The representative screw scrubber underflow sample was taken for grindability study as per Bond's method. The size analysis of the crushed product for grindability study was carried and the result is given in the Table 2.8. It was found that d_{80} of the feed material was 1870 micron. The grindability study was carried for 100 micron test sieve. The weight of the 700 cc of material was 1610 gm. For 250 percent circulating load, 460 gm of below 100 micron particles are to be produced at equilibrium revolution. To reach the equilibrium revolution a number of tests were carried out. At the equilibrium stage, G_{bp} was 1.972.

The size analysis of below 100 micron product was carried out. The size analysis of product is given in the Table 2.9. The overall grindability result of screw scrubber underflow is given in Table 2.10. The particle size description of feed and product is depicted in Fig. 2.4 and 2.5 respectively. The d_{80} of the ball mill product was 80 micron. Then according to equation, W.I. was calculated and it was found 10.0 kWh/short ton. It was converted to normal tonne and WI value is 11.0 kWh/tonne.

$$Wi = (44.5)/((P_1)^{0.23} \text{ X } (Gbp)^{0.82} (10/\surd P - 10/\surd F))$$

$$=(44.5)/((100)^{0.23} \text{ X } (1.972)^{0.82} (10/\surd 80 - 10/\surd 1870))$$

= 10.0 kWh/short ton = 10.0 X 1.1 = **11.0 kWh/tonne**

The bond work index of the sample is determined to be 11.0 kWh/tonne.

Table 2.8
Feed size analysis

Size, micron	Cum. Wt., % Passing
3360	100.00
2000	83.09
1400	56.91
1000	43.09
850	33.70
500	25.80
212	15.93
150	10.12
100	6.42
-100	0.00

Table 2.9
Size analysis of ground product

Size, micron	Cum Wt., % Passing
100	100.00
75	74.50
63	55.00
45	39.00
38	27.50
-38	0.00

Table 2.10
Results of gram per revolution

No. of revolutions	100micron produced (g)	100micron in the feed (g)	Net -100micron produced (g)	Grindability (g/rev.)
100	332	156	176	1.760
243	512	32.2	480	1.972
208	458	49.6	408	1.960
212	462	44.4	418	1.967
211	461	44.8	416	1.970
211	461	44.7	416	1.972
211	460	44.7	415	1.970
211	460	44.6	415	1.968
210	460	44.8	415	1.977

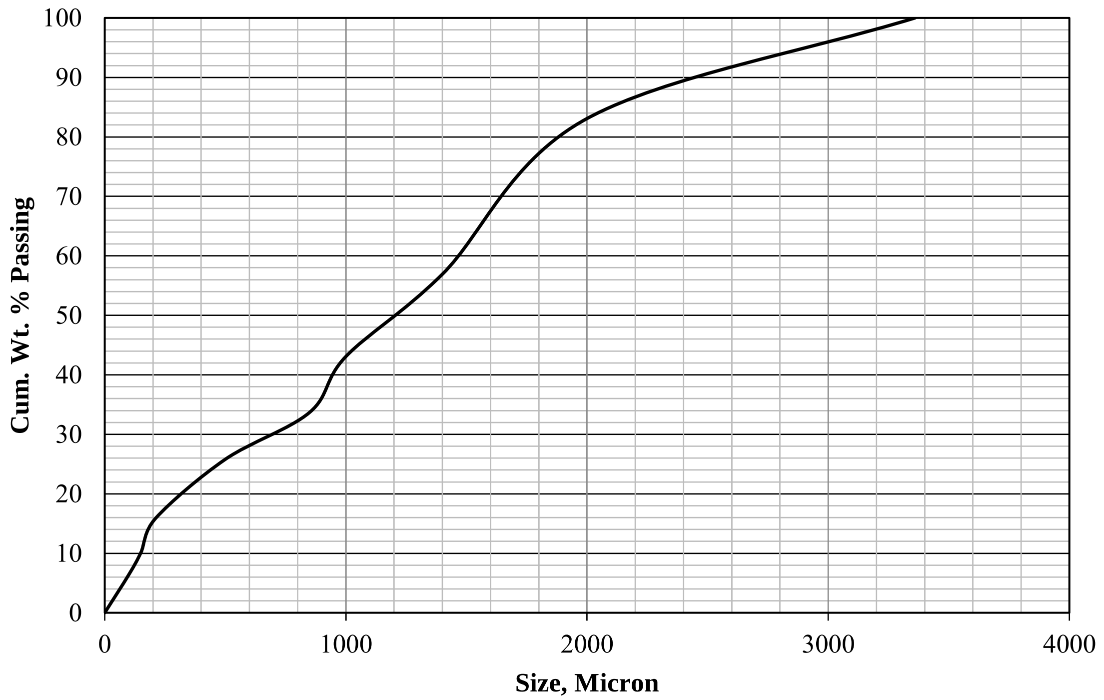


Fig. 2.4 Particle size distribution of feed

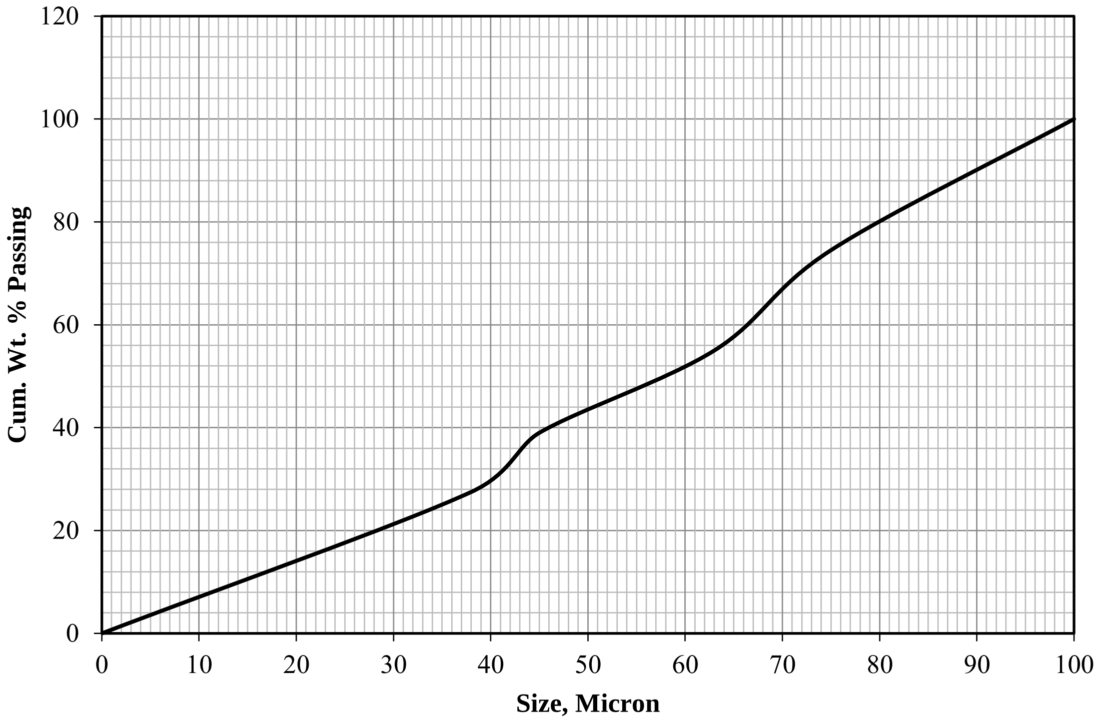


Fig. 2.5 Particle size distribution of product

2.6 Bulk Density

Bulk density is the weight of material in air per unit volume. It is measured by the help of a square sized metal container having length of each side 300 mm. Bulk density is evaluated by weighing a precisely measured known volume of ore sample. Natural moisture content is determined as per IS: 2720 (part 2) -1973. The bulk density of -10 mm sized sample is 1.997 kg/m^3 and its bulk density after being tapped is 2.242 kg/m^3.

2.7 Beneficiation Studies

The beneficiation study of the iron ore sample was carried out based on their mineralogy. According to size analysis studies, it contains good number of fine particles which may be iron phase minerals along with clay particles. In general, the fine clay particles are coated on the surface of the coarse particles. These clay minerals are responsible to increase the viscosity of slurry due to their swelling characteristics during the beneficiation process. Hence, it is essential to remove at the beginning of the process by scrubbing technique and discard as the reject. Hence the remaining materials can be processes smoothly for upgradation of iron values by physical beneficiation. As it contains 28.76% of below 45 microns and the top size is below 10mm, hence for attrition of particles, screw scrubber process is most suitable. This equipment also classifies simultaneously the fine particles in a single stage. The laboratory screw scrubber was used for desliming the slime particles at the feed rate of 200 kg/hr using water to solid ratio of 70:30. The screw scrubber gives two products i.e., overflow (slimes) and underflow (coarse particles). The sample was fed to the screw scrubber. The Fe content of scrubber underflow could be achieved to 63.61% with overall yield of 60.00% and overflow fraction contained 55.31% Fe with overall yield of 40.00%. The result of screw scrubber is given in the Table 2.11. The result shows that screw scrubber underflow is one of the final product and overflow need to be further processed. Attempt was made to enhance the grade of scrubber underflow by further process.

Table 2.11
Screw scrubber study of bulk sample

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Underflow	60.00	60.00	63.61	63.61
Overflow	40.00	100.00	55.31	60.29
Total	100.00		60.29	

The underflow of screw scrubber was further classified into two different size fractions viz. (-10+1mm, and -1mm). The Fe content of -10+1 mm size could be achieved to 63.95% with overall yield of 36.16%. The Fe content of -1 mm size could be achieved to 63.10% with overall yield of 23.84%. The result of classified sample is given in Table 2.12. The result shows -10+1 mm is having slightly more higher Fe value compared to -1mm size fraction.

Table 2.12
Size classification of screw scrubber underflow

Size, mm	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
-10+1	36.16	36.16	63.95	63.95
-1	23.84	60.00	63.10	63.61
Total	60.00		63.61	

The -10+1 mm size fraction of sample was processed in the batch type laboratory jig (Supplied by All Minerals, Germany). In each batch around 50kg sample was taken during experiment. It is a hydraulic jig operated with pneumatic control pulsating system. The pulse frequency was kept 60 cycle per minute and air flow rate 0.3 to 0.4 bar. The screen aperture used for bed was 1 mm size. After 30 minutes the material was collected from the chamber in layer by layer from top to bottom at particular thickness. The concentrate (Layer 1, Layer 2 and Layer 3) obtained by jigging of -10+1 mm fraction contains 64.68% Fe with yield of 39.15% and tailings contains 46.88% Fe with yield of 1.68%. The jigging study of -10+1 mm sample is given in the Table 2.13.

Table 2.13

Jigging study on -10+1 mm size fraction material

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Layer 1	28.09	28.09	65.26	65.26
Layer 2	8.07	36.16	63.51	64.87
Layer 3	2.99	39.15	62.36	64.68
Layer 4	1.68	40.82	46.88	63.95
Total	36.16		63.95	

The -1 mm size samples was processed in the spiral concentrator. Roughing and cleaning operations were carried out to enrich the concentrate grade. In both operations of roughing and scavenging, 30% solid concentration was maintained. The capacity of spiral concentrator is 1 tonne per hour. The Fe content of rougher concentrate could be achieved to 64.36% with overall yield of 19.51%. The Fe contains of scavenging concentrate, scavenging tailings and tailing fines could achieved 62.65%, 59.82% and 54.87% with overall yield 0f 4.33%, 3.94 % 1.18% respectively. The result of spiral concentrator is given in the Table 2.14.

Table 2.14

Spiral study of -1mm size fraction material

Details	Wt., %	Cum Wt., %	Fe, %	Cum. Fe, %
Rougher Concentrate	19.51	19.51	64.36	64.36
Scavenging Concentrate	4.33	23.84	62.65	64.05
Scavenging Tailings	3.94	27.78	59.82	63.45
Tailing Fines	1.18	28.97	54.87	63.10
Total	23.84		63.10	

The -10+1 mm size was further classified in two different size fractions viz. (-10+5 mm, and -5+1mm). The Fe content of -10+5 mm size could be achieved to 64.5% with overall yield of 18.12%. The Fe content of -5+1 mm size could be achieved to 63.40% with overall yield of 18.04%. The result of classified sample is given in Table 2.15.

Table 2.15
Size classification of -10+1 mm fraction

Size, mm	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
-10+5	18.12	18.12	64.50	64.50
-5+1	18.04	36.16	63.40	63.95
Total	36.16		63.95	

The -10+5 mm and -5+1 mm size fraction of samples were processed in the batch type laboratory jig. In each batch around 50kg sample was taken for experiment. The pulse frequency was kept 60 cycle per minute and air flow rate 0.3 to 0.4 bar. The screen aperture used for bed was 1 mm size. After 30 minute the material was collected from the chamber in layers from top to bottom at particular thickness. The concentrate (Layer 1, Layer 2 and Layer 3) obtained by jigging of -10+5 mm fraction contains 65.23% Fe with yield of 17.44% and tailings contains 46.10% Fe with yield of 0.69%. The jigging study of -10+5 mm sample is given in Table 2.16. The concentrates (Layer 1, Layer 2 and Layer 3) obtained by jigging of -5+1 mm fraction contains 64.62% Fe with yield of 16.80% and tailings contains 46.81% Fe with yield of 1.24%. The jigging study of -5+1 mm sample is given in Table 2.17.

Table 2.16
Jigging study on -10+5 mm size fraction material

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Layer 1	13.88	13.88	65.51	65.51
Layer 2	2.53	16.41	64.70	65.39
Layer 3	1.03	17.44	62.71	65.23
Layer 4	0.69	18.12	46.10	64.50
Total	18.12		64.50	

Table 2.17
Jigging study on -5+1 mm size fraction material

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Layer 1	12.91	12.91	65.1	65.10
Layer 2	2.09	15.00	63.5	64.88
Layer 3	1.80	16.80	62.52	64.62
Layer 4	1.24	18.04	46.81	63.40
Total	18.04		63.40	

The overflow of screw scrubber is to be deslimed by hydrocyclone to remove the ultrafine gangue minerals directly. The screw scrubber overflow sample was fed to the rougher hydrocyclone. The hydrocyclone gives two products i.e., overflow (very ultrafine slimes particle) and underflow (fine coarse particles). The Fe content of hydrocyclone underflow could be achieved to 60.71% Fe with overall yield of 20.93% and overflow fraction contained 49.39% Fe with overall yield of 19.07%. The rougher hydrocyclone overflow sample was fed to the scavenging hydrocyclone at the density 1040 kg/m^3. The Fe content of scavenger hydrocyclone underflow could be achieved to 56.98% Fe with overall yield of 6.54% and overflow fraction contained 45.43% Fe with overall yield of 12.52%. The rougher and scavenging hydrocyclone study are given in Table 2.18 and 2.19.

Table 2.18

Rougher hydrocyclone study of screw scrubber overflow

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Underflow	20.93	20.93	60.71	60.71
Overflow	19.07	40.00	49.39	55.31
Total	40.00		55.31	

Table 2.19

Scavenging hydrocyclone study

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Underflow	6.54	6.54	56.98	56.98
Overflow	12.52	19.07	45.43	49.39
Total	19.07		49.39	

If the overflow of hydrocyclone contains ultrafine hematite particles and are not the discardable, then the screw scrubber overflow will be beneficiated directly using WHIMS/HGMS.

The overflow of screw scrubber was fed to HGMS (supplied by LONGI). The magnetic intensity of LONGI is 12000 gauss. The feed density was kept at 1.06 kg/m^3. The Fe content of the rougher magnetic fraction of LONGI could be achieved to 61.99% Fe with overall yield of 22.65% whereas non-magnetic fraction contains 45.04% Fe with overall yield of 13.12%. The rougher non-magnetic fraction was fed to the scavenging LONGI. The Fe content of the scavenging magnetic fraction of LONGI could be achieved to 56.10% Fe with overall yield of 1.04% and non-magnetic fraction contains 41.02% Fe with overall yield of 2.60%. The rougher and scavenging magnetic separation results are given in Table 2.20and 2.21.

Table 2.20
LONGI study of screw scrubber overflow

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Concentrate	22.65	22.65	61.99	61.99
Middlings	4.23	26.88	51.45	60.33
Tailings	13.12	40.00	45.04	55.31
Total	40.00		55.31	

Table 2.21
LONGI scavenging study

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Concentrate	3.15	3.15	56.10	56.10
Middlings	2.10	5.25	43.51	51.06
Tailings	7.87	13.12	41.02	45.04
Total	13.12		45.04	

The rougher and scavenging hydrocyclone underflow were blended together and given in Table 2.22. The blended material fed to LONGI. The intensity of magnetic separator (Longi) having 12000 gauss in pilot scale. The result of rougher LONGI study is given in the Table 2.23. The Fe content of the rougher magnetic fraction could be enhanced to 63.83%Fe with overall yield of 19.21%. The rougher middling could be achieved 62.97%Fe with overall Yield of 2.59% and non-magnetic fraction from rougher tailings contains 44.80%Fe with overall yield of 5.67%. The rougher tailings of LONGI was further fed to scavenger stage of LONGI. The Fe content of the scavenging magnetic fraction could be enhanced to 58.69%Fe with overall yield of 2.46%. The scavenging middling contains 45.31%Fe with overall Yield of 0.45% and non-magnetic fraction from scavenging tailings contains 32.39%Fe with overall yield of 2.77%. The result of scavenger LONGI is given in the Table 2.24.

Table 2.22
Blending of hydrocyclone underflows

Details	Wt., %	Cum Wt., %	Fe, %	Cum. Fe, %
Rougher hydrocyclone underflow	20.93	20.93	60.71	60.71
Scavenging hydrocyclone underflow	6.54	27.48	56.98	59.82
Total	27.48		59.82	

Table 2.23
LONGI study of blended product

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Concentrate	19.21	19.21	63.83	63.83
Middlings	2.59	21.80	62.97	63.73
Tailings	5.67	27.48	44.80	59.82
Total	27.48		59.82	

Table 2.24
LONGI scavenging study

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Concentrate	2.46	2.46	58.69	58.69
Middlings	0.45	2.90	45.31	56.63
Tailings	2.77	5.67	32.39	44.80
Total	5.67		44.80	

The overflow of hydrocyclone was fed to LONGI. The magnetic intensity of LONGI is 12000 gauss. The result of rougher LONGI study is given in the Table 2.25. The Fe content of the rougher magnetic fraction could be enhanced to 53.35%Fe with overall yield of 3.37%. The rougher middling could be achieved 48.52%Fe with overall Yield of 0.72% and non-magnetic fraction from rougher tailings contains 42.00%Fe with overall yield of 8.43%. The rougher tailings of LONGI was further fed to scavenger LONGI. The Fe content of the scavenging magnetic fraction could be enhanced to 47.47%Fe with overall yield of 1.92%. The scavenging middling contains 42.27%Fe with overall Yield of 0.55% and non-magnetic fraction from scavenging tailings contains 40.21%Fe with overall yield of 5.96%. The result of scavenger LONGI is given in the Table 2.26.

Table 2.25
LONGI study of hydrocyclone overflow

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Concentrate	3.37	3.37	53.35	53.35
Middlings	0.72	4.09	48.52	52.50
Tailings	8.43	12.52	42.00	45.43
Total	12.52		45.43	

Table 2.26
LONGI scavenging study

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Concentrate	1.92	1.92	47.47	47.47
Middlings	0.55	2.47	42.27	46.31
Tailings	5.96	8.43	40.21	42.00
Total	8.43		42.00	

Based on the above study and considering on the quality and quantity on the final product, following process were carried out. The beneficiation study was carried out by using screw scrubbing of the ROM sample followed by the magnetic separation of the screw scrubber overflow. The results are given in the Table 2.27 and Table 2.28. The overall product is given in the Table 2.29 and the overall reject is given in the Table 2.30. The chemical analysis of the product and reject are given in the Table 2.31 and 2.32 respectively and the process flowsheet is shown in Figure 2.8.

Table 2.27
Scrubbing study of bulk sample

Details	Wt., %	Cum Wt., %	Fe, %	Cum. Fe, %
Underflow	60.00	60.00	63.61	63.61
Overflow	40.00	100.00	55.31	60.29
Total	100.00		60.29	

Table 2.28
Magnetic separation study of screw scrubber overflow

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Mag	22.65	22.65	61.99	61.99
Middling	4.23	26.88	51.45	60.33
Non-Mag	13.12	40.00	45.04	55.31
Total	40.00		55.31	

Table 2.29
Overall products

Details	Wt., %	Fe, %
Screw Scrubber underflow	60.00	63.61
Rougher MS Conc.	22.65	61.99
Total	82.65	63.17

Table 2.30
Overall rejects

Details	Wt., %	Fe, %
Rougher Middling	4.23	51.45
Rougher Tailings	13.12	45.04
Total	17.35	46.60

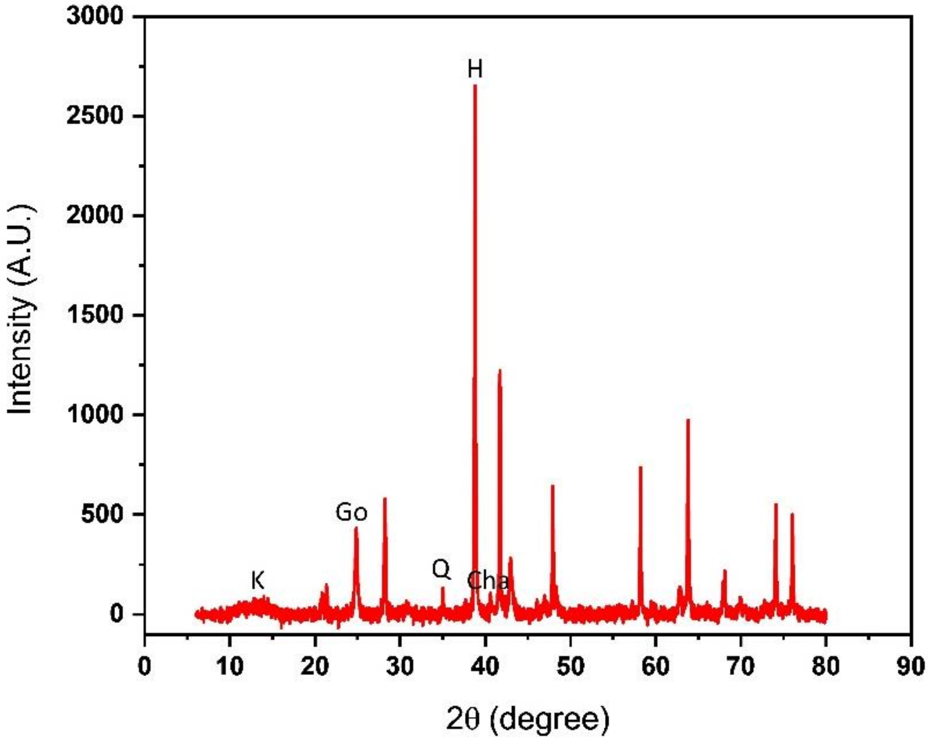
Table 2.31
Chemical analysis of the product

Details	Scrubber U/F	Magnetic Conc.	Overall
Fe (T)	63.61	61.99	63.17
Fe_2O_3	90.96	88.65	90.33
SiO_2	2.23	3.55	2.59
Al_2O_3	1.61	2.06	1.73
LOI	4.37	5.09	4.57

Table 2.32
Chemical analysis of the reject

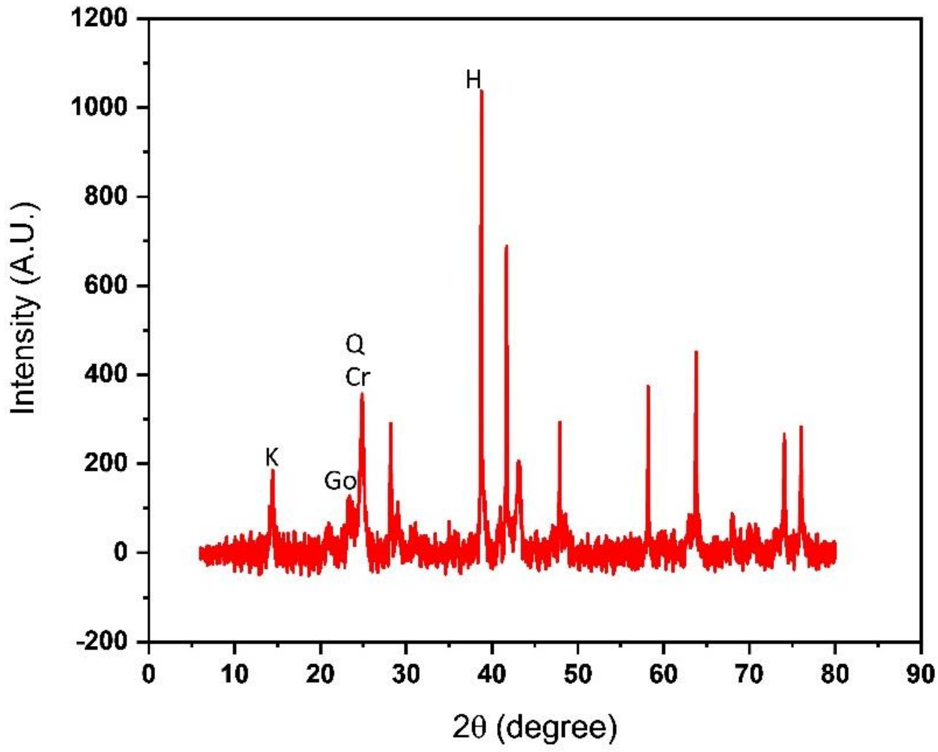
Details	Percentage
Fe (T)	46.60
Fe_2O_3	66.64
SiO_2	7.03
Al_2O_3	17.46
LOI	8.80

XRD study was carried out on the product and reject sample to determine the major minerals present in the samples. The XRD results are shown in Fig. 2.6 and 2.7. It indicates that the product sample have hematite as the major mineral phase and other minerals are goethite, quartz and kaolinite; while the reject sample have hematite as the major mineral phase and other minor minerals are quartz, goethite, cristobilite and quartz.



H: Hematite, Go: Goethite, Q: Quartz, K: Kaolinite; Ch: Chantalite

Fig. 2.6 XRD study of product sample



H: Hematite, Go: Goethite, Q: Quartz, K: Kaolinite, Cr: Cristobilite

Fig. 2.7 XRD study of reject sample

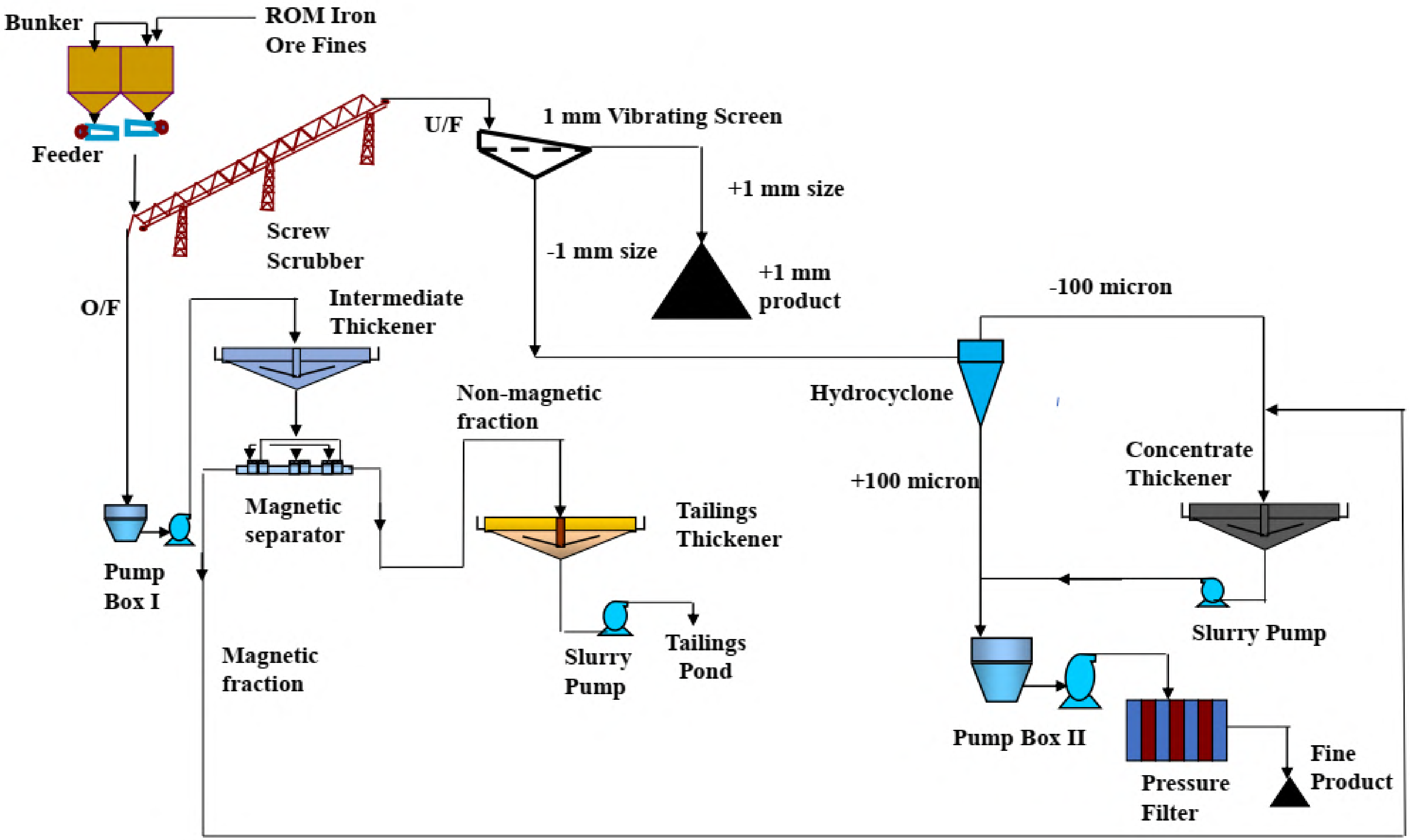


Fig. 2.8 Process flowsheet for washing of low grade iron ore of Nuagoan

2.8 Pressure Filtration Study

The pressure filtration study of magnetic separation concentrate and magnetic separation tailings were carried out by using Diemme Filter press and the results are given in Table 2.32 and Table 2.33 respectively.

Fig. 2.9 Pilot scale pressure filter set up

Table 2.32
Pressure filtration result of magnetic separation concentrate

Parameters	Exp. 1
Solid % in feed	60
Feeding time, min	11
Feeding pressure, bar	6
Air purging time, min	9
Air purging pressure, bar	7
Squeezing time, min	5
Squeezing pressure, bar	11
Total filtration time, min	22
Weight of cake (Wet), Kg	66
Cake Thickness, mm	25
Filtrate (water)	35
Cake moisture, %	16

Table 2.33
Pressure filtration result of magnetic separation tailings

Parameters	Exp. 1
Solid % in feed	30
Feeding time, min	15
Feeding pressure, bar	7
Air purging time, min	10
Air purging pressure, bar	8
Squeezing time, min	10
Squeezing pressure, bar	13
Total filtration time, min	35
Weight of cake (Wet), Kg	25
Cake Thickness, mm	18
Filtrate (water)	40
Cake moisture, %	21.6

2.9 Settling Studies

2.9.1 Materials Preparation

After processing of the iron ore, the tailing and concentrate samples were taken for the settling study to provide the basic data for design of thickeners for tailings and concentrate.

2.9.2 Experimental Method

The settling study was carried out in a graduated measuring cylinder of 1 liter capacity. Different solid concentration like 20% to 35% in increment of 5% of concentrate and 5% to 10% in the increment of 2.5% tailing samples are prepared. The pH of the concentrate sample was maintained at 6.5 and the pH of tailing is 6.5. This is due to pH as the received in the process. The interface height was observed against the time intervals. The interface level with respect to time was recorded in each case.

2.9.3 Results and Discussion

The settling study was carried out on concentrate sample at different solids concentration of 20%, 25%, 30% & 35%. The pH of the sample was kept at 6.5 as the sample was received from the process at the same pH. The results of experiments were shown in Figures 2.10 to 2.14. It has been observed that the settling rate decreases with increasing of solid percentage. In case of 20% of solid concentration, the settling rate is 2.0 m/hr. Different dosses of flocculent was used to enhance the settling rate of solid. Very low doses of flocculent is required at lower solid concentration to get satisfactory results to design the conventional thickener. At higher solid concentration, the flocculent dosage requirement is little high.

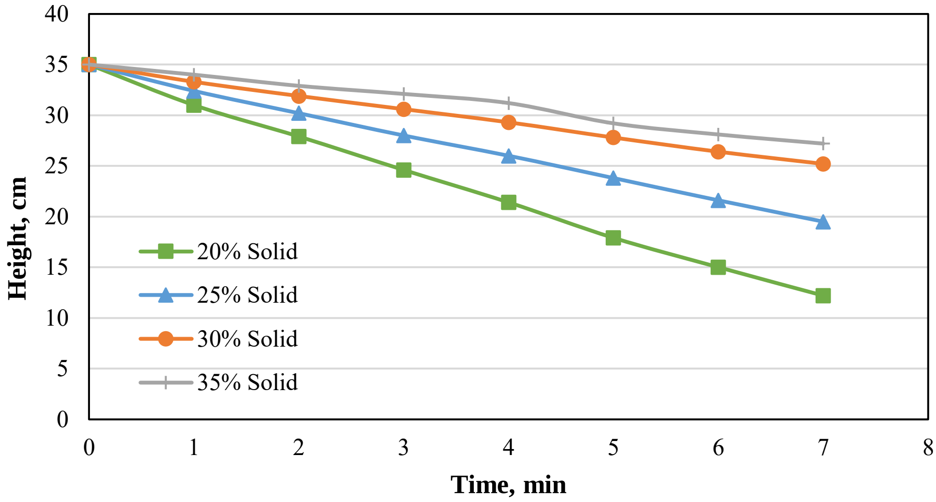


Fig. 2.10 Settling study of iron ore concentrate at different solid concentration

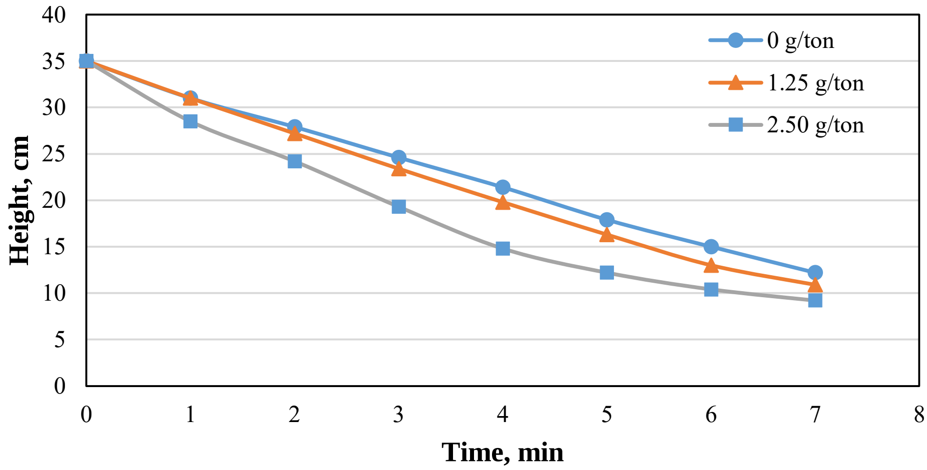


Fig. 2.11 Iron ore concentrate settling study at 20% solid concentration with different doses of flocculent

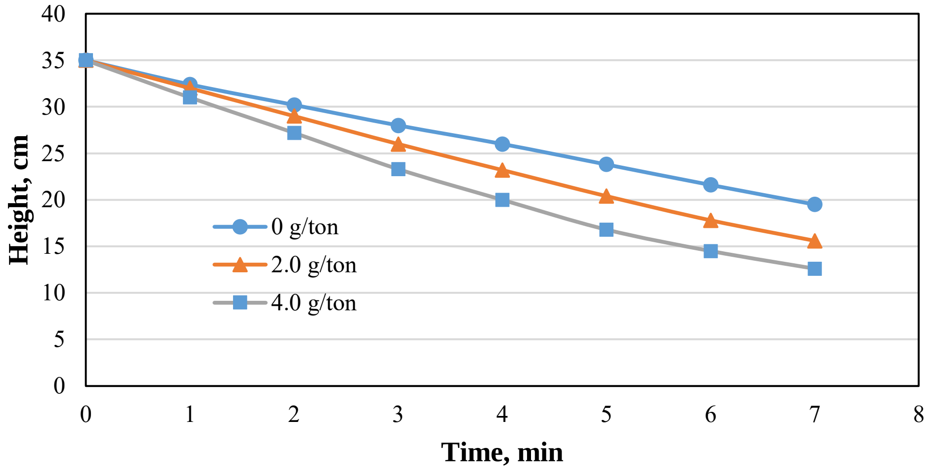


Fig. 2.12 Iron ore concentrate settling study of 25% solid concentration with different doses of flocculent.

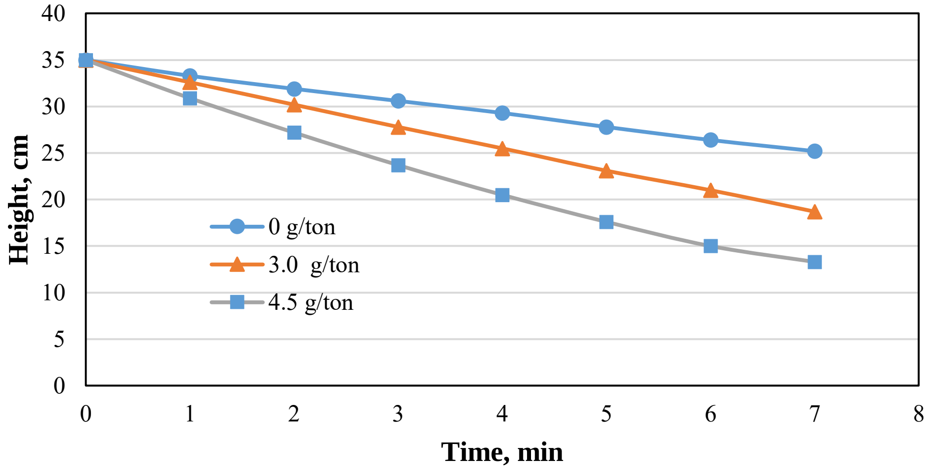


Fig. 2.13 Iron ore concentrate settling study of 30% solid concentration with different doses of flocculent.

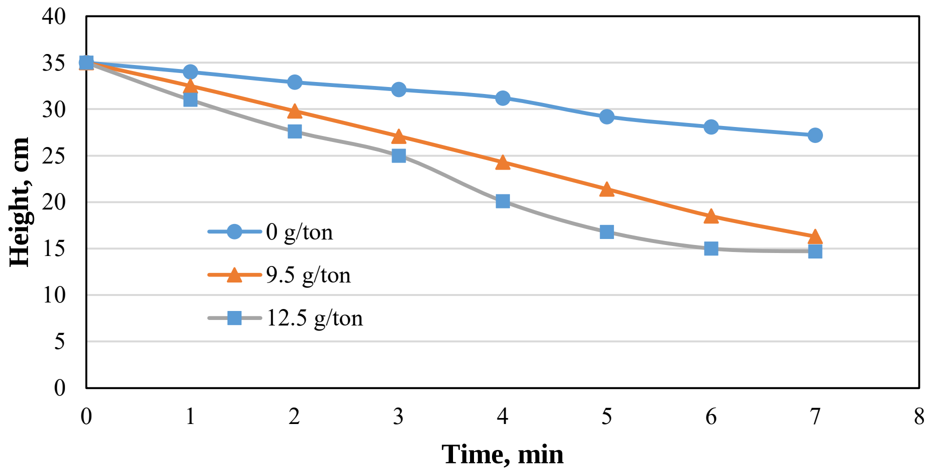


Fig. 2.14 Iron ore concentrate settling study of 35% solid concentration with different doses of flocculent

Similarly settling studies of iron ore tailings were carried out at different concentration of 5%, 7.5% and 10%. The tests were carried out without and with addition of flocculent. The tests results are shown in Figure 2.15 to 2.18. It has been observed that the settling rate decreases with increasing of solid percentage. In case of 5% of solid concentration, the settling rate is 2 m/hr whereas in case 15 %, the settling rate is 0.8 m/hr. The flocculent rate was varied from 6.52 gm/tonne to 30 gm/tonne of solid. The settling rate with flocculent is very high at lower solid concentration. It indicates that after 5% solid concentration, the flocculent may require at lower dosage to enhance the settling rate. At higher solid concentration, the flocculent dosage requirement is high. At 10% solid concentration, the settling rate is very poor even after adding the flocculent.

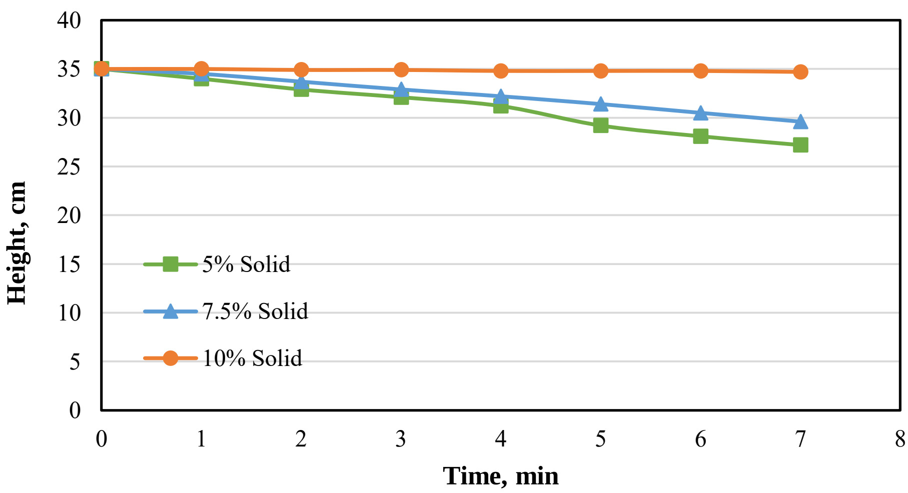


Fig. 2.15 Iron ore tailings settling study of different solid concentration

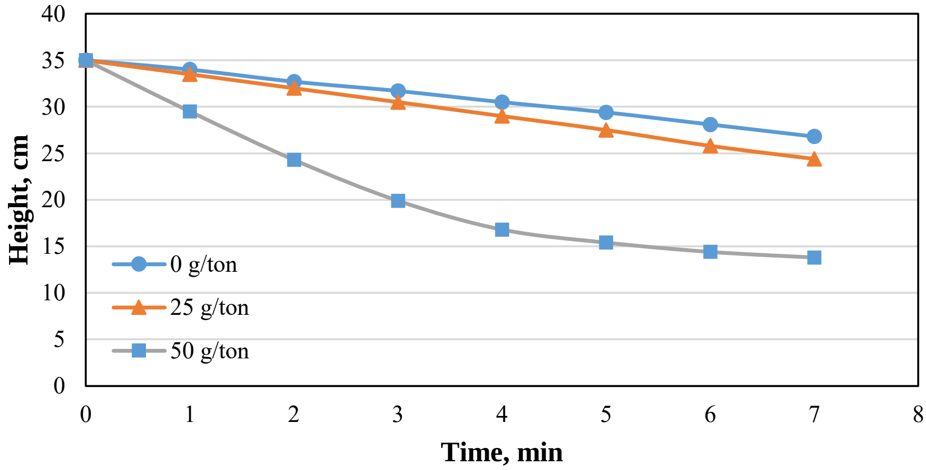


Fig. 2.16 Iron ore tailings settling study at 5% solid concentration with different doses of flocculent

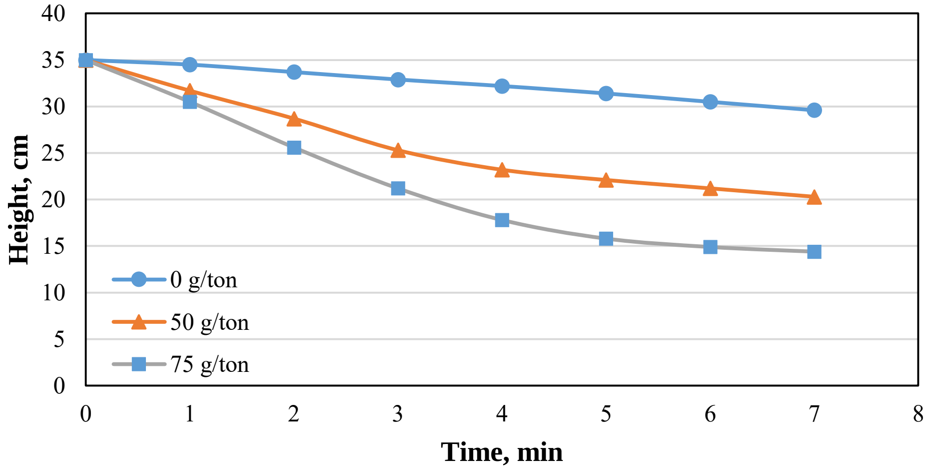


Fig. 2.17 Iron ore tailings settling study at 7.5% solid concentration with different doses of flocculent

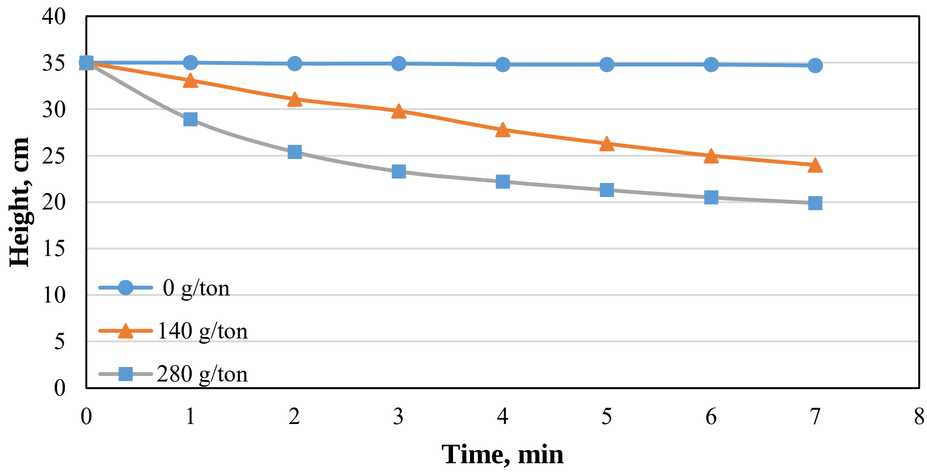


Fig. 2.18 Iron ore tailings settling study at 10% solid concentration with different doses of flocculent

2.10 Conclusions

The results of settling studies indicate the following observations;

1. The settling rate in case of tailings sample is very slow due to presence of ultra-fine clay minerals. Because of its surface charge, those try to remain in dispersion mode. The flocculent helps to neutralize the surface charge and make agglomerates the ultra-fine particles, as a result, the settling rate enhances.
2. The settling rate for conventional thickener design is required around 20 cm within 5-6 minutes. The above results are matching these phenomena.
3. For concentrate sample, small dose of flocculants was required to be added as there was less clay mineral compared to the tailings.

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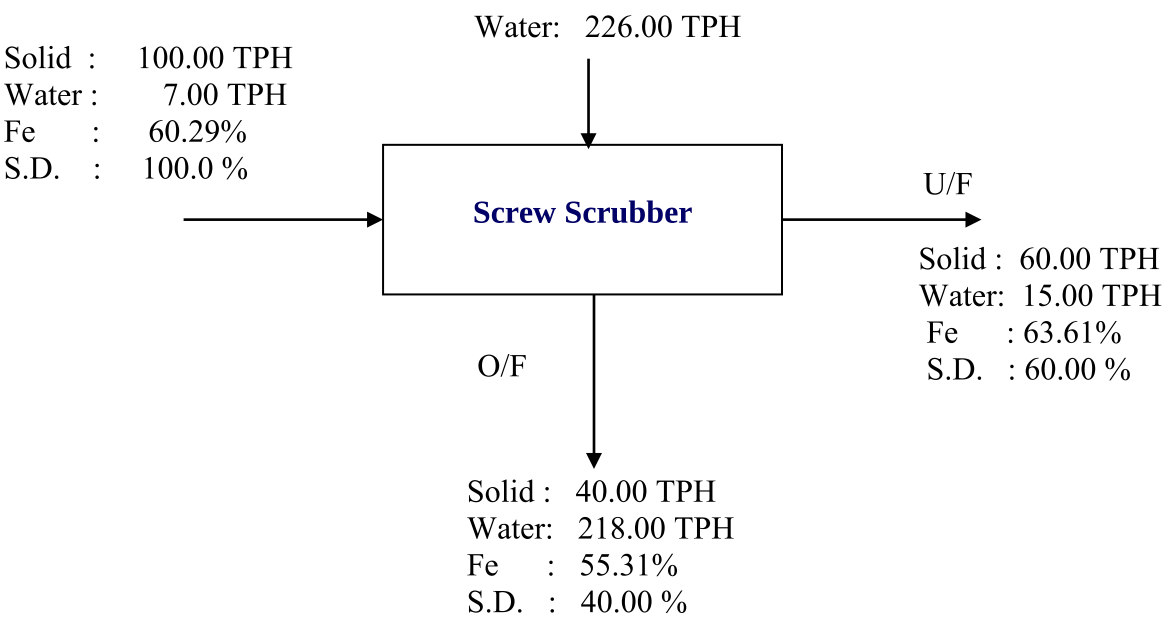
Annexure I.A

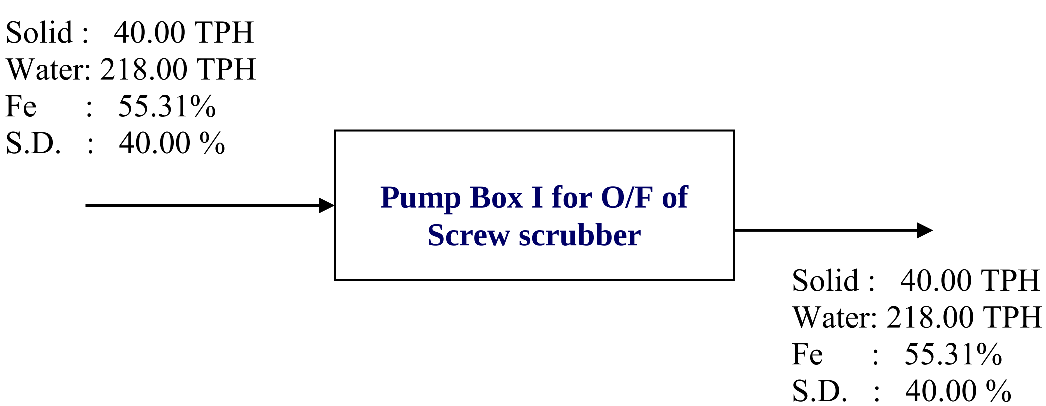
Material Balance of Process (Nuagaon Iron ore)

Basis: 100 TPH

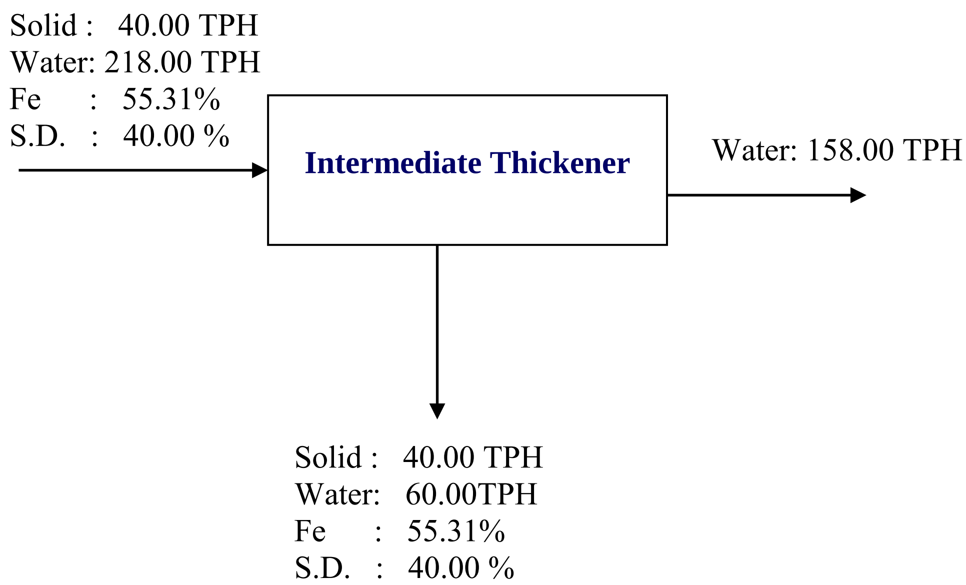
1. Screw Scrubber



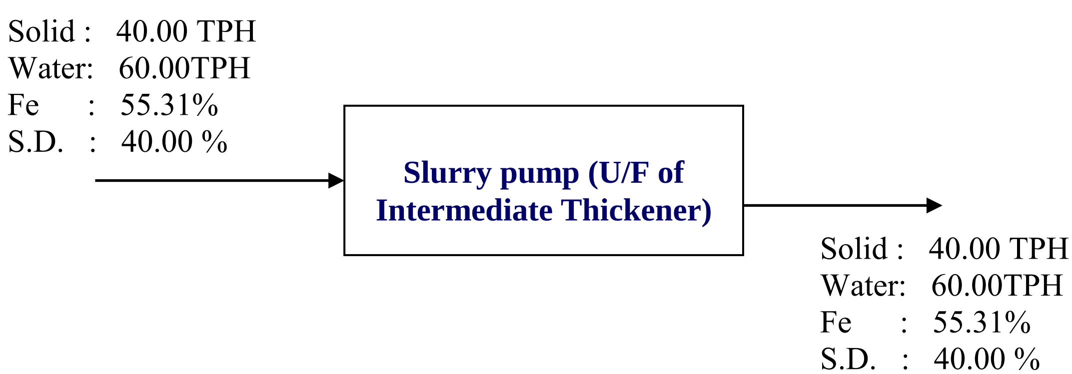
2. Pump Box I (O/F of Screw scrubber)



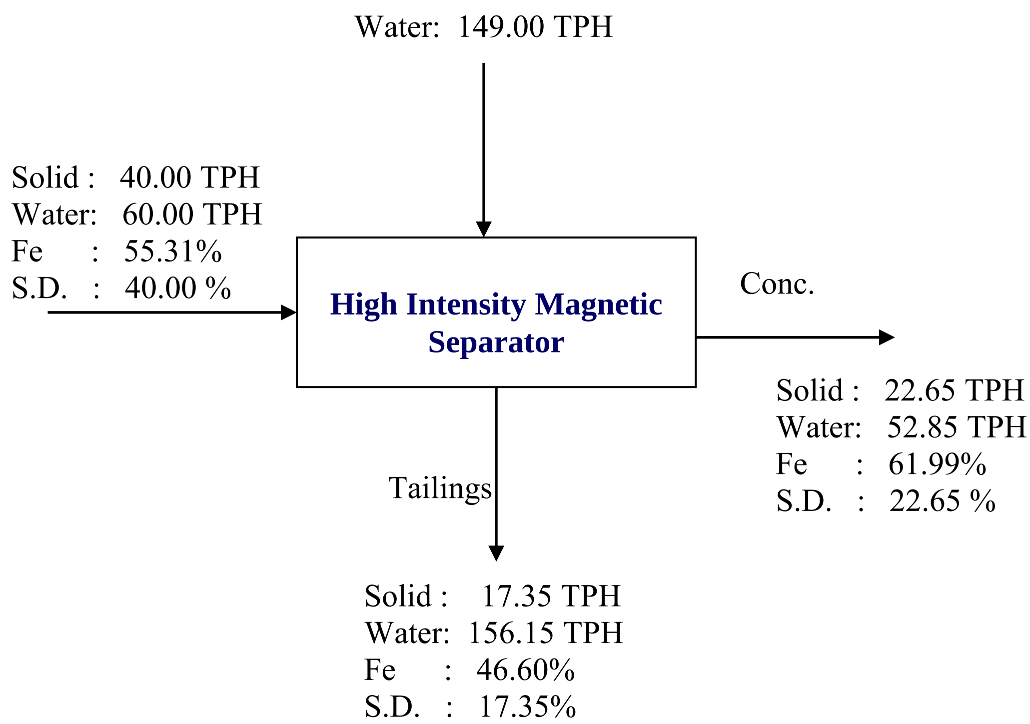
3. Intermediate Thickener



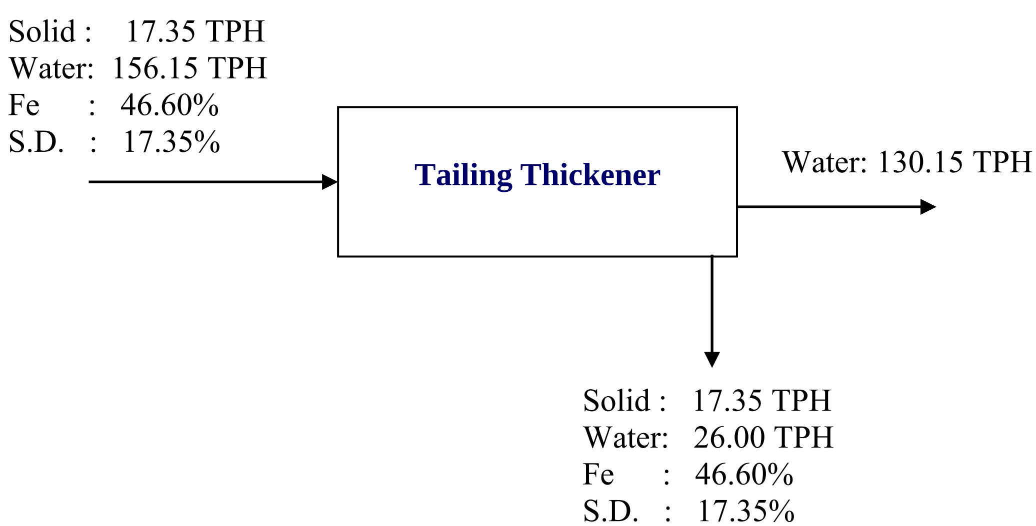
4. Slurry Pump I (U/F of intermediate thickener)



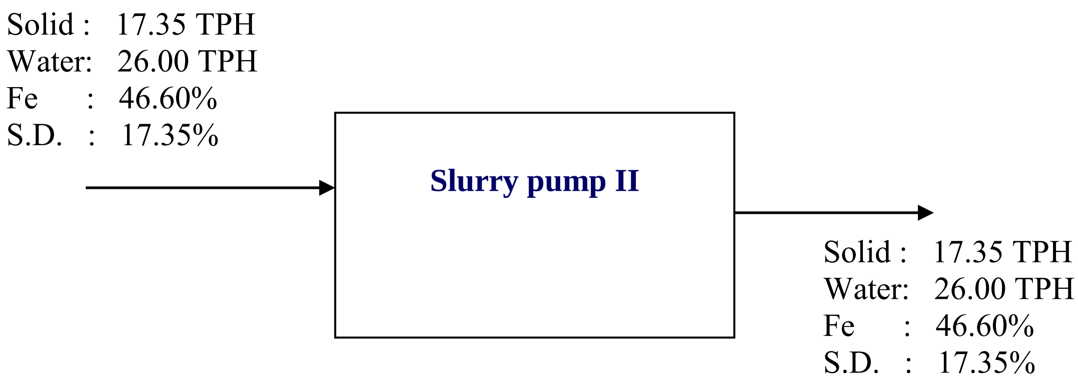
5. High Intensity Magnetic Separator



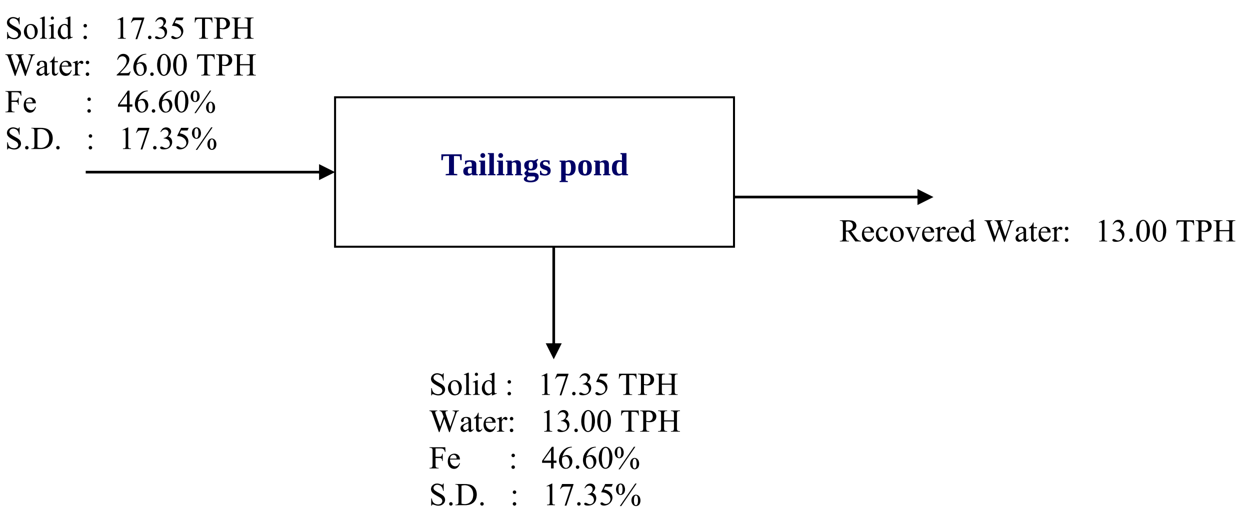
6. Tailing Thickener



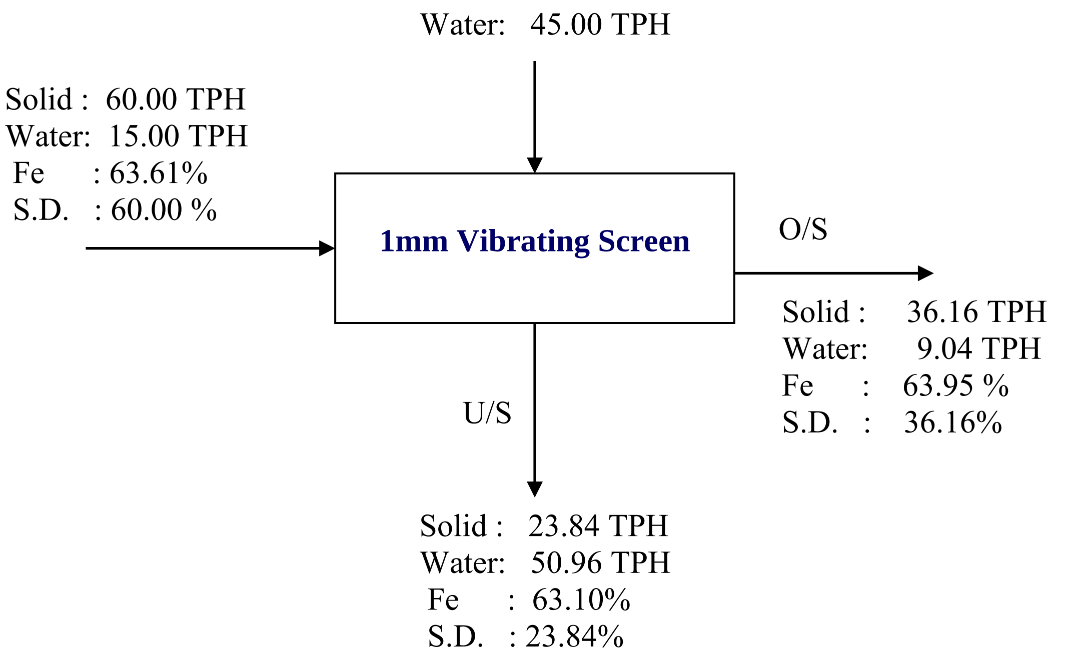
7. Slurry Pump II



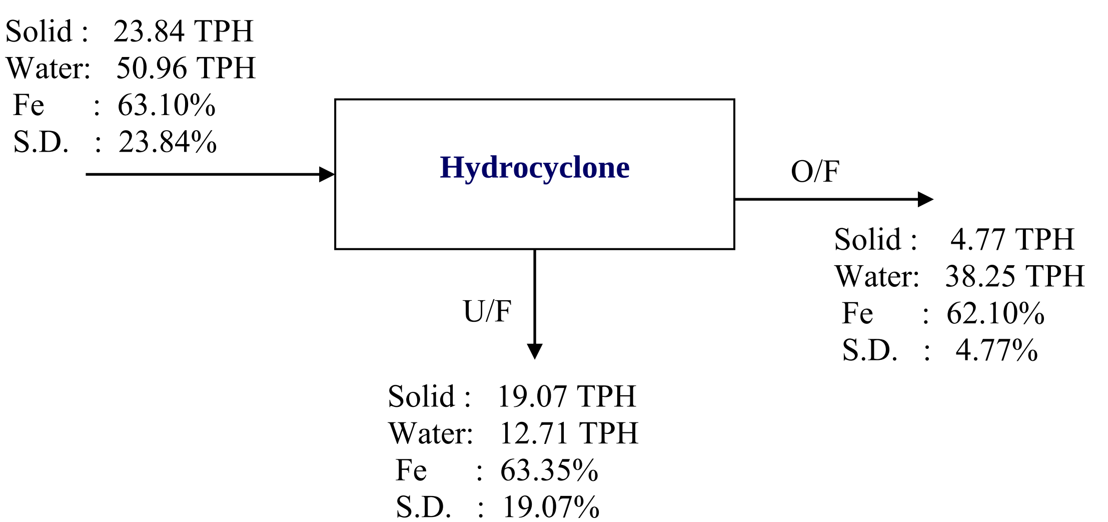
8. Tailings Pond



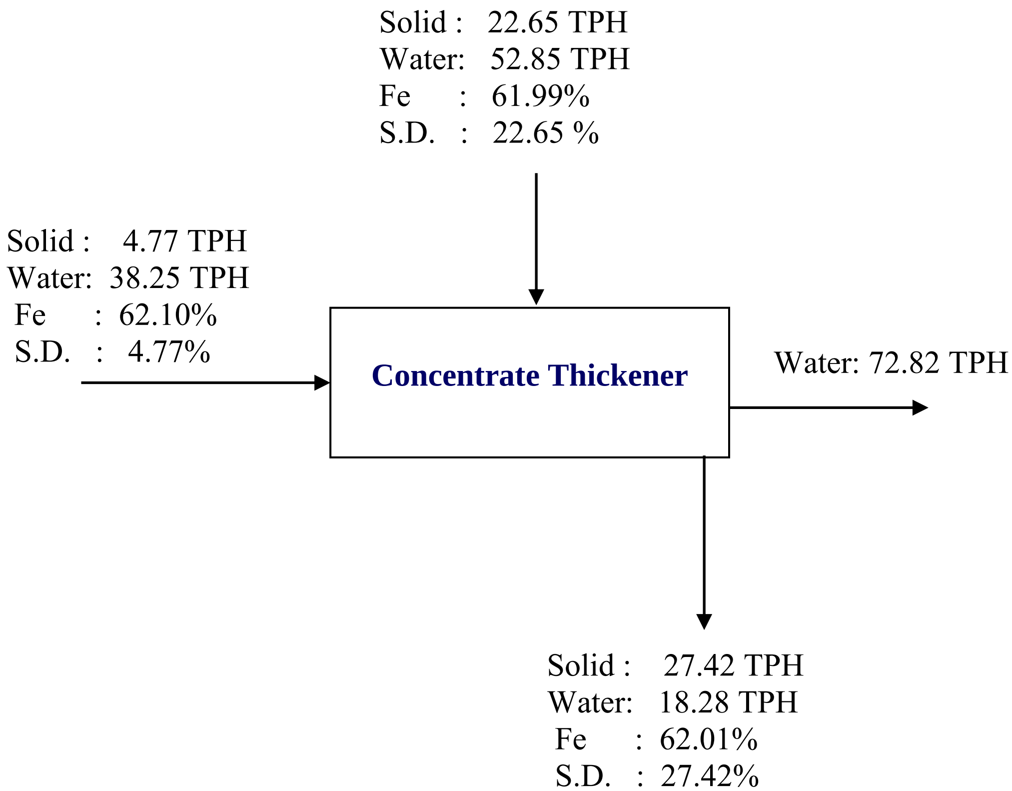
9. Vibrating Screen (1 mm size)



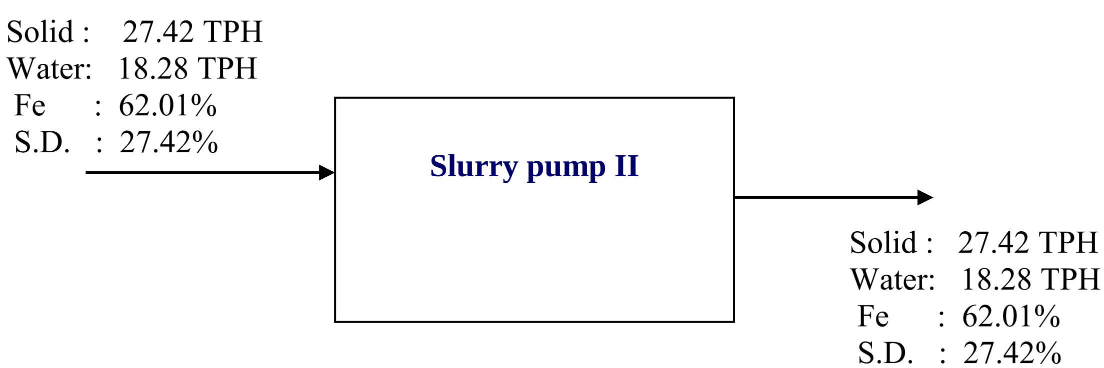
10. Hydrocyclone



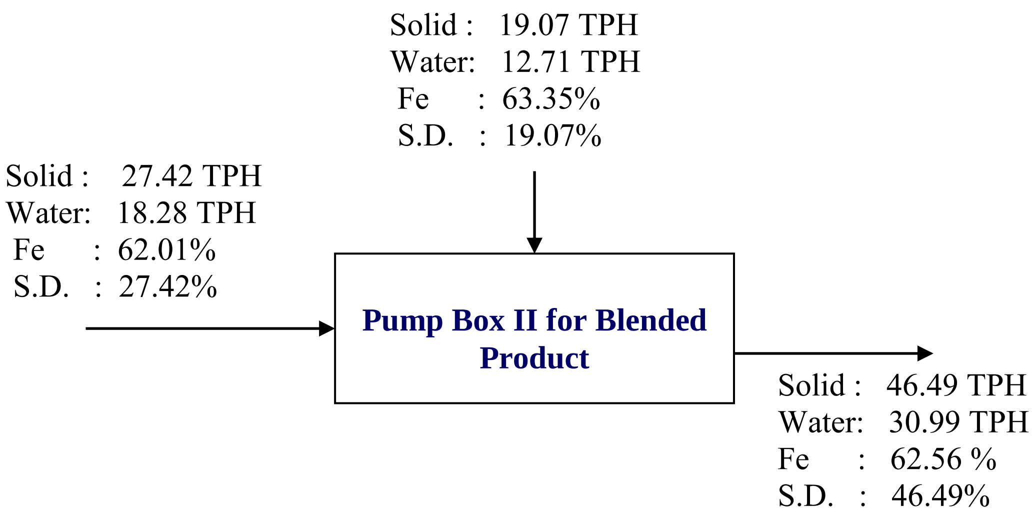
11. Concentrate Thickener



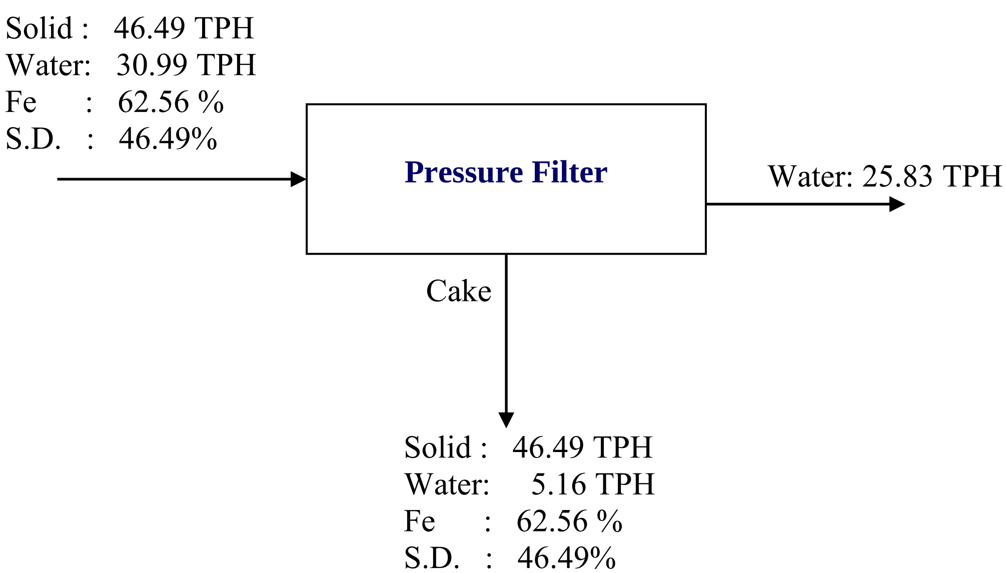
12. Slurry Pump II for Concentrate Thickener



13. Pump Box II (Blended Product)



14. Pressure Filter



Water Balance

A. Water Handling

Sl. No.	List of Equipment	Water Addition, TPH
1	Bulk Sample	7.00
2	Screw Scrubber	226.00
3	Vibrating Screen	45.00
4	Magnetic Separator	149.00
Total		**427.00**

B. Water Recovered

Sl. No.	List of Equipment	Water recovered, TPH
1	Intermediate Thickener	158.00
2	Concentrate Thickener	72.82
3	Pressure Filter	25.83
4	Tailings Thickener	130.15
5	Tailing Pond	13.00
Total		**399.80**

C. Water Contains in Products

Sl. No.	Name of the Product	Water Contain, TPH
1	Pressure Filter	5.16
2	Vibrating screen	9.04
3	Tailing pond	13.00
Total		**27.20**

D. Make up water

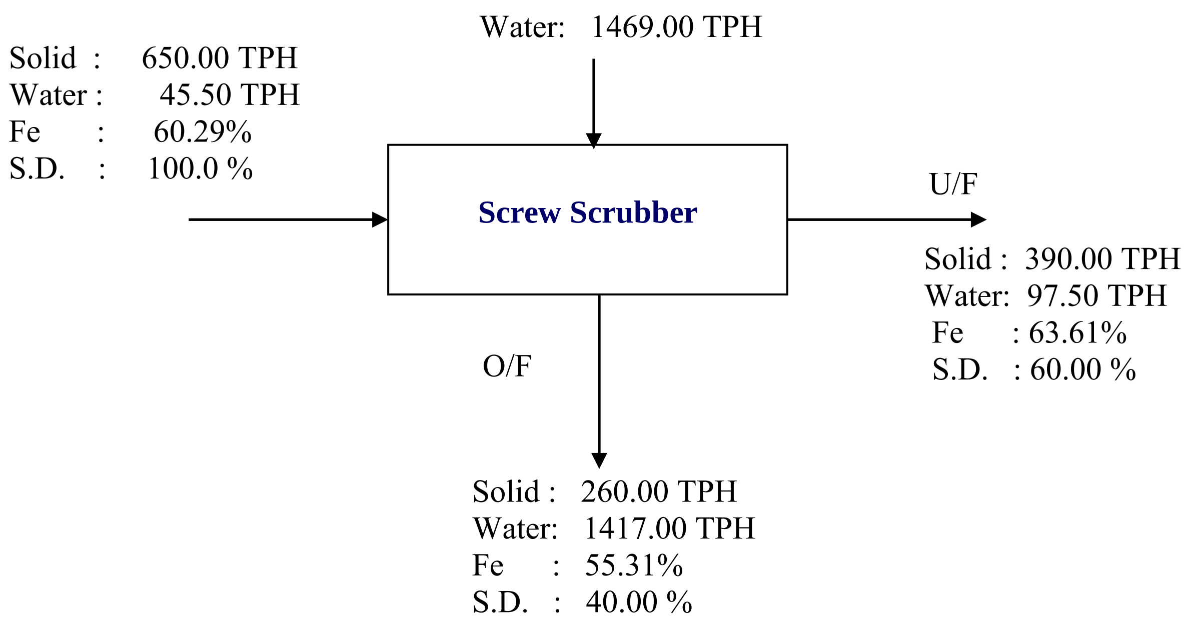
Sl. No.	Name of the Product	Water Contain, TPH
1	Water content in products	14.20
2	Water content in tailings	13.00
3	1% of handling loss	4.27
Total		**31.47**

Annexure I.B

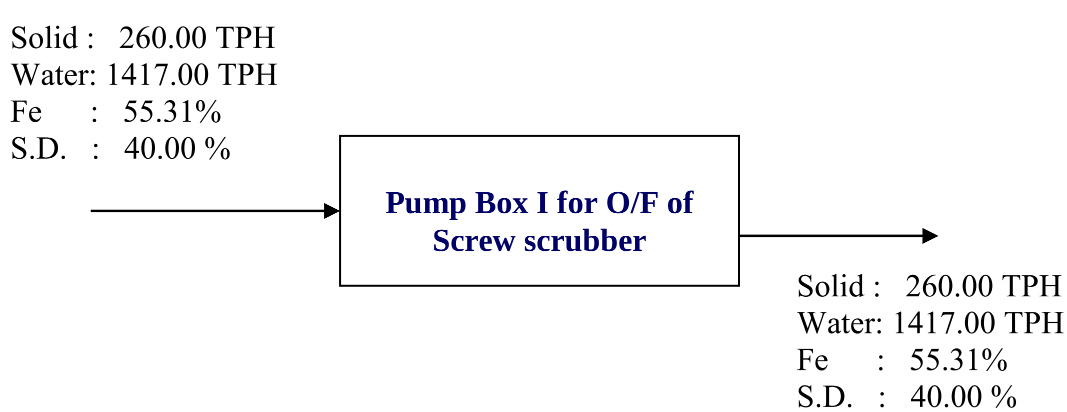
Material Balance of Process (Nuagaon Iron ore)

Basis: 650 TPH

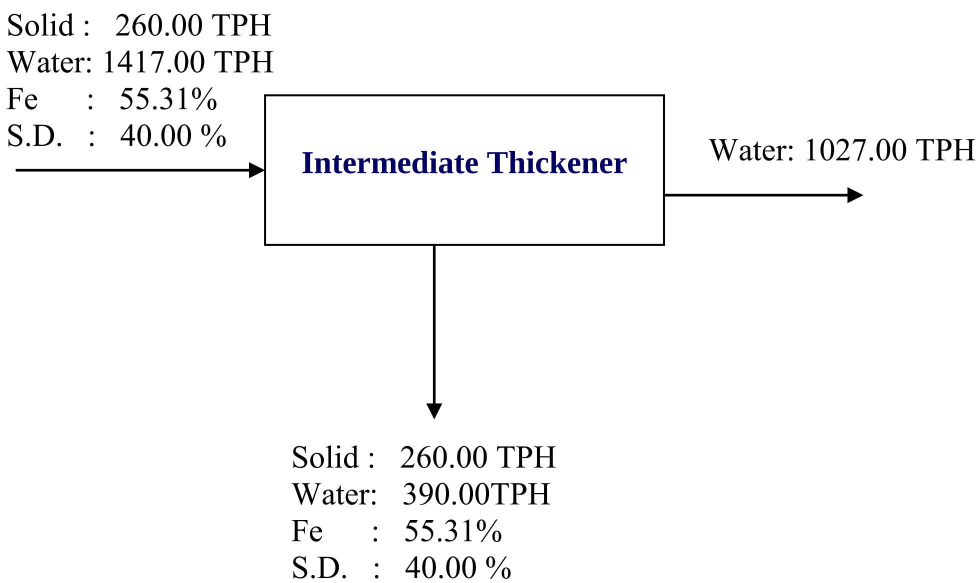
1. Screw Scrubber



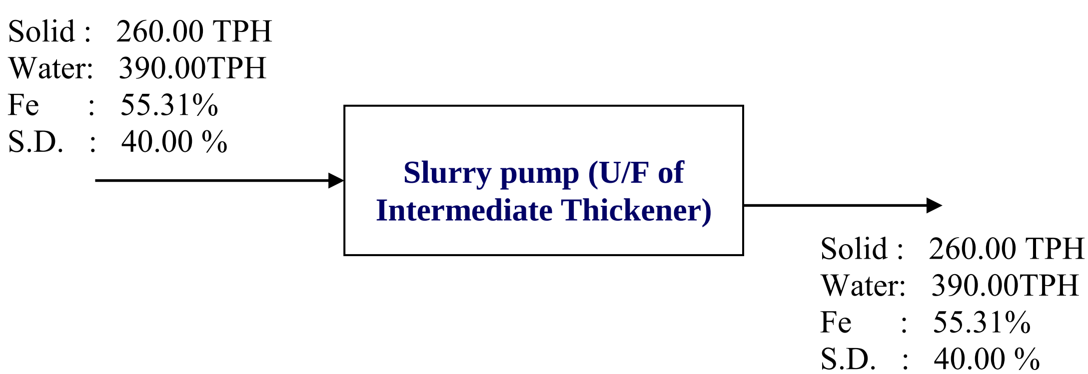
2. Pump Box I (O/F of Screw scrubber)



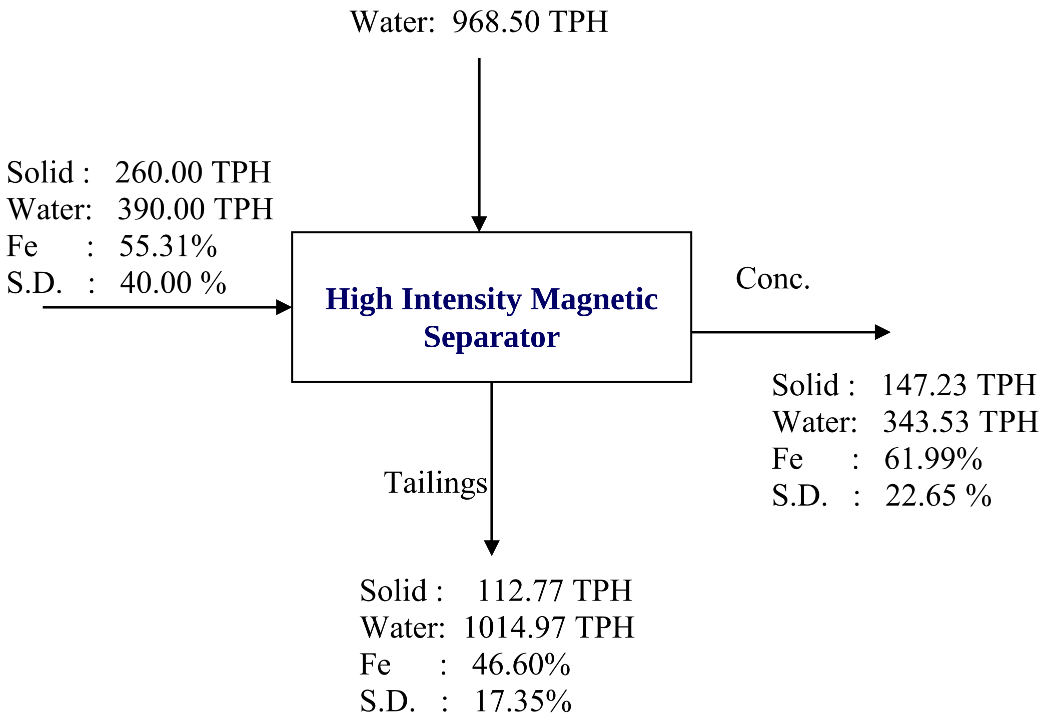
3. Intermediate Thickener



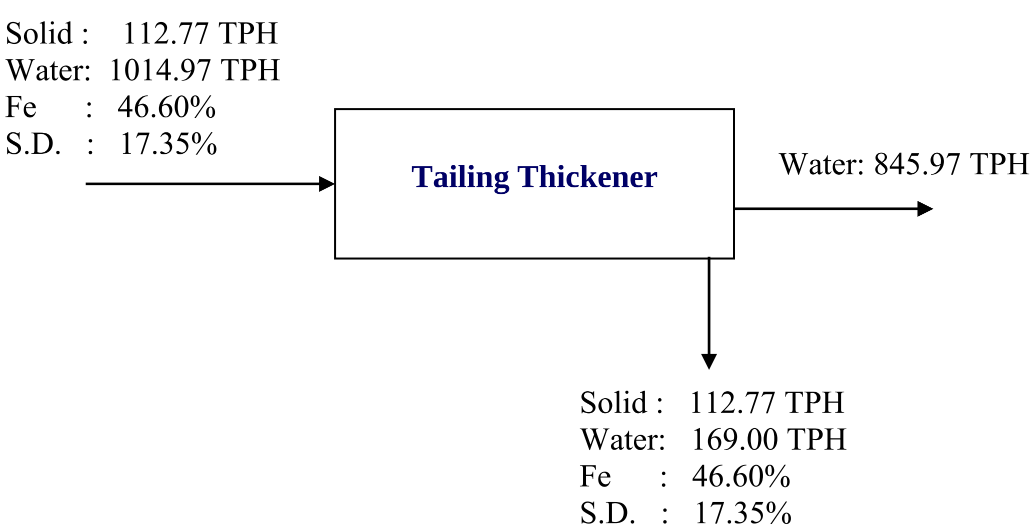
4. Slurry Pump I (U/F of intermediate thickener)



5. High Intensity Magnetic Separator



6. Tailing Thickener



7. Slurry Pump II

Solid : 112.77 TPH
Water: 169.00 TPH
Fe : 46.60%
S.D. : 17.35%

Slurry pump II

Solid : 112.77 TPH
Water: 169.00 TPH
Fe : 46.60%
S.D. : 17.35%

8. Tailings Pond

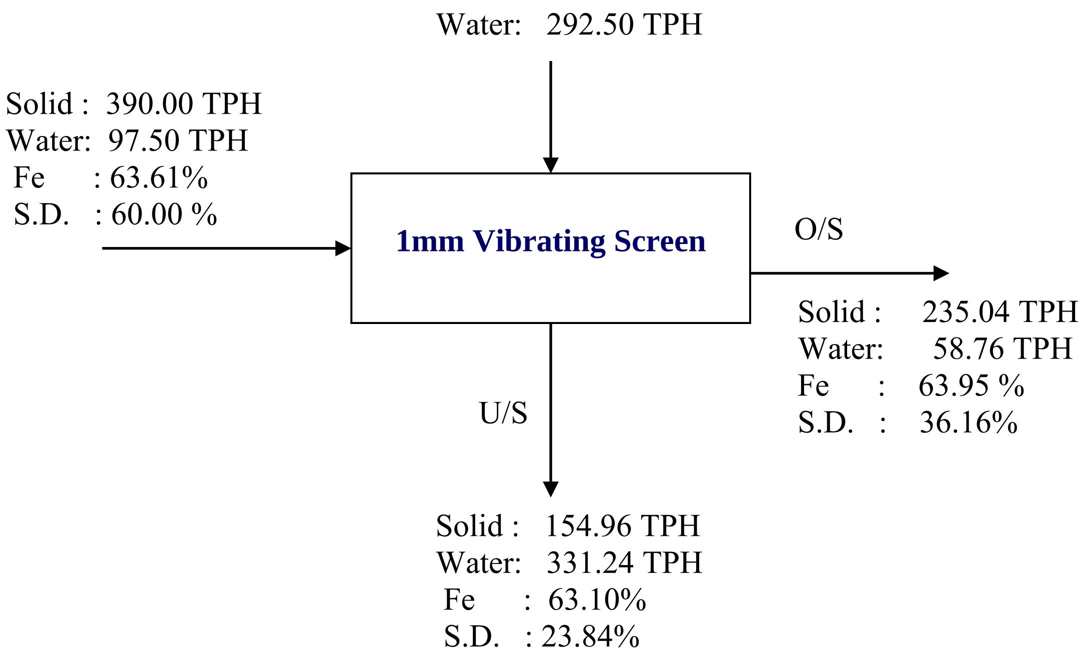
Solid : 112.77 TPH
Water: 169.00 TPH
Fe : 46.60%
S.D. : 17.35%

Tailings pond

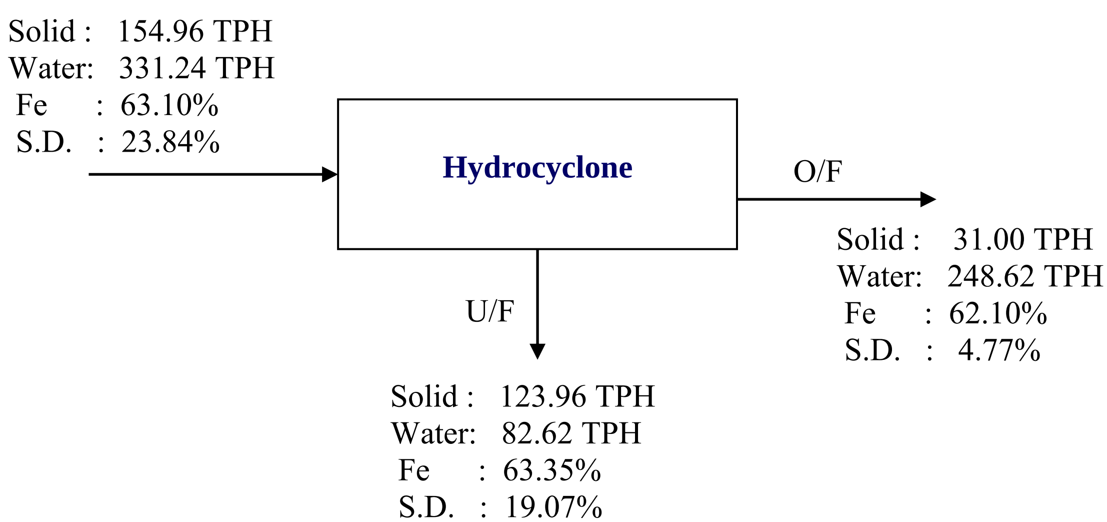
Recovered Water: 84.50 TPH

Solid : 112.77 TPH
Water: 84.50 TPH
Fe : 46.60%
S.D. : 17.35%

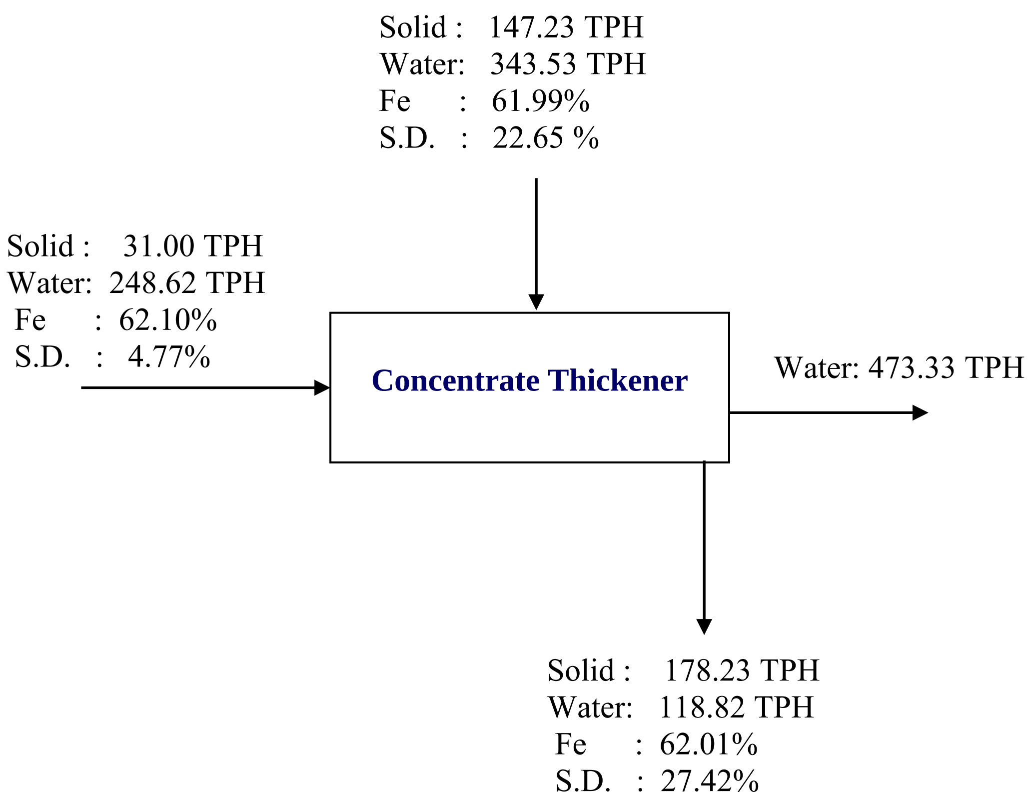
9. Vibrating Screen (1 mm size)



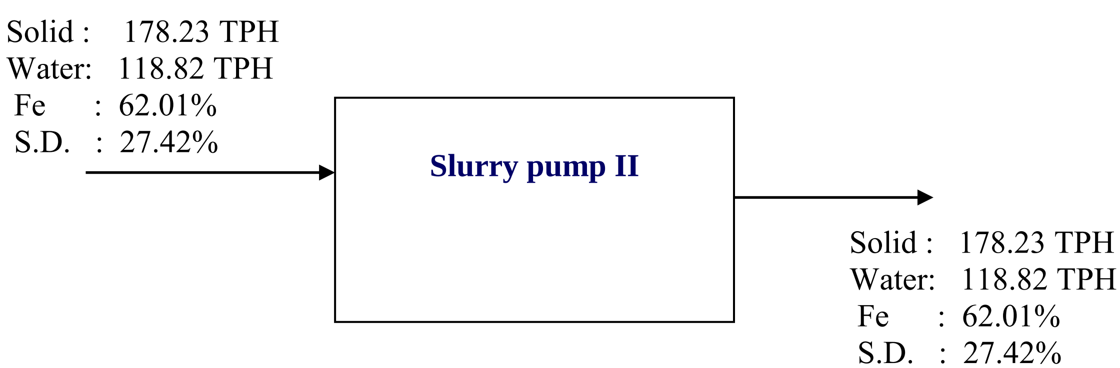
10. Hydrocyclone



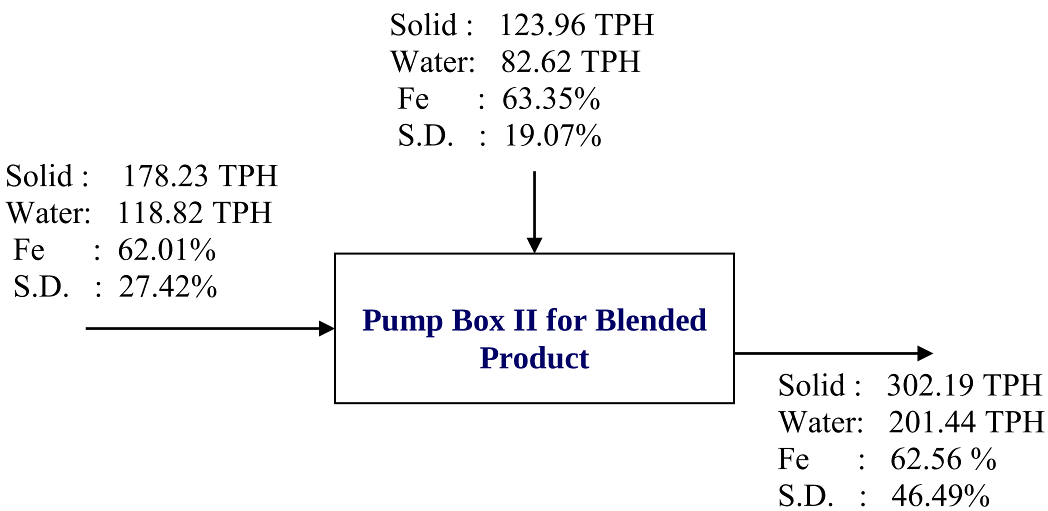
11. Concentrate Thickener



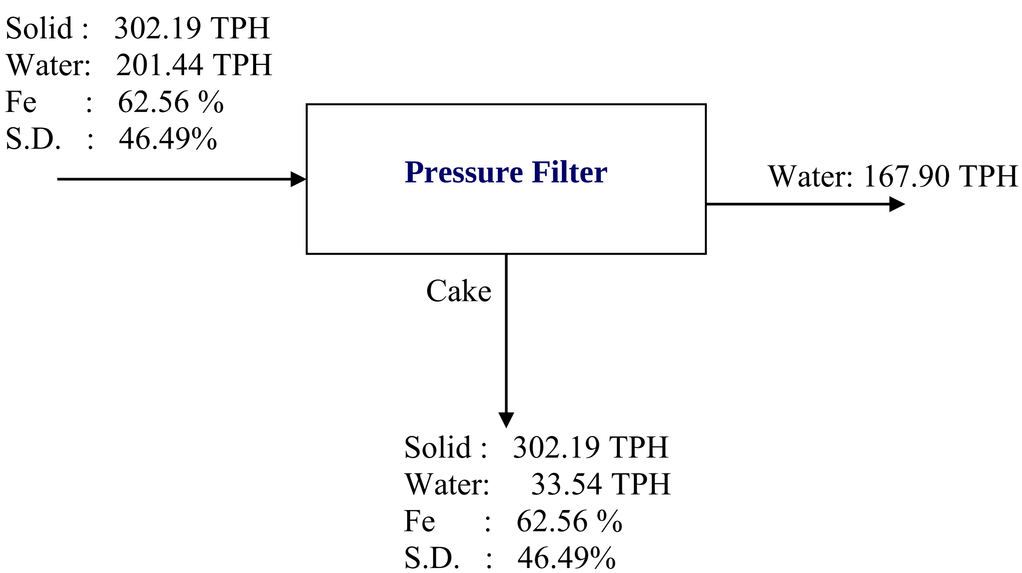
12. Slurry Pump II for Concentrate Thickener



13. Pump Box II (Blended Product)



14. Pressure Filter



Water Balance

A. Water Handling

Sl. No.	List of Equipment	Water Addition, TPH
1	Bulk Sample	45.50
2	Screw Scrubber	1469.00
3	Vibrating Screen	292.50
4	Magnetic Separator	968.50
Total		**2775.50**

B. Water Recovered

Sl. No.	List of Equipment	Water recovered, TPH
1	Intermediate Thickener	1027.00
2	Concentrate Thickener	473.33
3	Pressure Filter	167.90
4	Tailings Thickener	845.97
5	Tailing Pond	84.50
Total		**2598.7**

C. Water Contains in Products

Sl. No.	Name of the Product	Water Contain, TPH
1	Pressure Filter	33.54
2	Vibrating screen	58.76
3	Tailing pond	84.50
Total		**176.8**

D. Make up water

Sl. No.	Name of the Product	Water Contain, TPH
1	Water content in products	92.30
2	Water content in tailings	84.50
3	1% of handling loss	27.76
Total		**204.56**

Chapter 3

Characterization, Beneficiation and Dewatering Studies of Narayanposhi Sample

3.1 Introduction

Around 1 tonnes of Iron ore below 10 mm sample was received from Narayanposhi Iron ore mines, Barbil, Odisha to carry out the desliming and beneficiation study to develop the suitable process flowsheet for production of high-grade iron ore concentrate. Around 100 kg representative sample was taken by standard coning and quartering method for size analysis, chemical analysis, bond work index, mineralogical studies and bulk density of bulk sample. The remaining sample was processed for desliming and beneficiation studies.

3.2 Characterisation Study

3.2.1 Size & Fe Analysis of Bulk Sample

The total sample of around 1 tonnes was thoroughly mixed and representative sample was drawn by coning and quartering method for size analysis. Then the size analysis with respective Fe analysis of bulk sample was carried out and the result is given in Table 3.1. The remaining sample was subjected to beneficiation studies.

Table 3.1

Size and Fe analysis of bulk sample

Size, mm	Wt., %	Cum Wt., %	Fe, %	Cum. Fe, %
+10	9.48	9.48	63.05	63.05
+6	20.03	29.51	62.83	62.90
+3	17.30	46.81	61.70	62.46
+2	7.09	53.90	61.51	62.33
+1	13.20	67.09	61.13	62.10
+0.850	5.68	72.77	60.03	61.93
+0.500	3.84	76.62	61.64	61.92
+0.300	3.03	79.65	61.43	61.90
+0.210	2.93	82.58	60.14	61.84
+0.150	1.79	84.37	60.24	61.80
+0.100	1.24	85.61	60.34	61.78
+0.075	0.45	86.06	60.56	61.78
+0.045	0.98	87.04	60.22	61.76
-0.045	12.96	100.00	54.21	60.78
Total	100.00		60.78	
Bulk			60.76	

3.2.2 Detail Chemical Analysis

The detailed chemical analysis, LOI along with the trace elements of the bulk sample was carried out. The result is given in the Table 3.2. The major impurity is quartzite and aluminum oxide. The hematite percent in the ore is about 86.88 %.

Table 3.2
Detail chemical analysis of the bulk sample

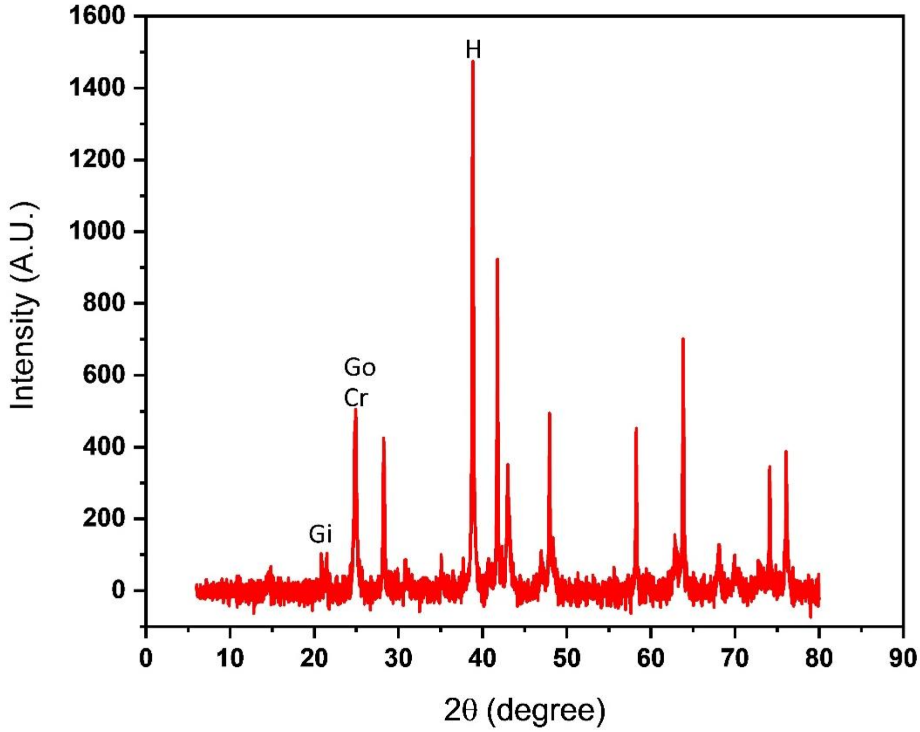
Details	Percentage
Fe (T)	60.76
Fe_2O_3	86.88
SiO_2	2.75
Al_2O_3	4.16
CaO	0.014
Cr_2O_3	0.020
CuO	0.006
K_2O	0.057
MgO	0.048
MnO_2	0.072
Na_2O	0.015
NiO	0.004
P_2O_5	0.004
PbO	0.006
TiO_2	0.004
V_2O_5	0.013
ZnO	0.014
LOI	6.18

3.3 Mineralogical Study

Mineralogical study of the bulk sample was carried out by using X-ray diffraction study. This study gives the qualitative mineralogical identification of different phases present with their textures.

3.3.1 XRD Study

XRD study was carried out on the representative bulk sample to determine the major minerals present in the sample. The XRD result is shown in Fig. 3.1 It indicates that the bulk sample have hematite as the major mineral phase and other minerals are goethite, gibbsite and chromite.



H: Hematite, Go: Goethite, Gi: Gibbsite, Cr: Chromite

Fig. 3.1 XRD study of bulk sample

3.4 Sequential Heating Analysis of Bulk Sample

The sequential heating at different temperature was carried out using muffle furnace for bulk sample to determine the association of minerals like goethite, gibbsite, kaolinite and overall LOI content. The result of sequential heating is given in Table 3.3. Based on weight loss at different temperatures, percentage of goethite, gibbsite and kaolinite were calculated. The percentage of water loss during 108°C to 450°C is used to calculate the percentage of goethite and gibbsite mineral. The percentage of water loss during 450°C 850°C is used to calculate the percentage of kaolinite mineral. The percentage of water loss during 850°C 950°C is used to calculate the percentage of carbonate minerals. Mineralogical characteristion study carried out by using both heating cycle and chemical analysis is given Table 3.4.

Table 3.3
LOI at different temperature by sequential heating cycle of bulk sample

400°C	850°C	950°C	Total LOI, %
5.42	0.71	0.05	6.18

Table 3.4
Mineralogical characteristics study by using heating cycle and chemical analysis

Heating Cycle Analysis	**Hematite, %**	**Goethite, %**	**Kaolinite, %**	**Gibbsite, %**
	48.16	43.32	5.12	2.97
Chemical Analysis	**Fe(T), %**	**LOI, %**	**Al_2O_3, %**	**SiO_2, %**
	60.76	6.18	4.16	2.75

3.5. Estimation of Bond Work Index

3.5.1 Sample Preparation

Around 30 kg of representative bulk sample was taken and screened at 4.36 mm size. The +3.36 mm size was crushed to below 3.36 mm size by using roll crusher. Then, it was thoroughly mixed and the representative sample was drawn for grindiability study for determination of Bond Work Index (BWI).

3.5.2 Ball Mill Grindiability Process

Grindiability study was carried out as per the standard procedure described by Bond. The Bond ball mill work index determination is carried out in a standard test mill and under standard conditions. The test mill has an internal diameter of 12 inch and length is also 12 inch. It has a smooth lining with rounded corners, no lifters except for a 4” X 8” hand hole lid for charging.

It has a revolution counter and runs at 70 rpm. The grinding charge consists of 285 iron balls weighing 20.125 kg. It consists of about 43 numbers of 1.45” balls, 67 numbers of 1.17” balls, 10 numbers of 1” balls, 71 numbers of 0.75” balls and 94 numbers 0.61” balls with a calculated surface area of 842 sq inch.

The standard feed was prepared by passing all through 3.36 mm size. It was packed by shaking in a 1000 cc graduated cylinder, and the weight of 700 cc was placed in the mill and ground dry at 250 percent circulating load. After the first grinding period of 100 revolutions, the mill was dumped; the ball charge was screened out and 700 cc of material was screened on 150 mesh (100 micron) with coarser protecting sieves if necessary. The undersize was weighed and fresh unsorted feed was added to oversize to bring its weight back to that of original charge. Then it was returned on to the balls in the mill and ground for the number of revolutions calculated from the results of the previous period to produce sieve undersize equal to 1/3.5 of the total charge in the mill. The grinding period cycles were continued until the net grams of sieve undersize produced per mill revolution reaches equilibrium and reverses its direction of increase or decrease. Then the undersize product and circulating load were screen analyzed, and the average of the last three net grams per revolution (G_{bp}) was the mill grindiability. When F is the size in microns which 80 percent of the new ball mill feed passes, P is the microns which 80 percent of the last cycle sieve undersize product passes, and P_1 is the opening in microns of sieve size tested (100 micron), then the ball mill work index W_i is calculated from the following revised equation;

$$W.\ I. = 44.5 / \{ (P_i)^{0.23} \ X\ (G_{bp})^{0.82}\ X\ 10\ (1/\sqrt{P} - 1/\sqrt{F}) \} \qquad \textbf{(3.1)}$$

3.5.3 Bond Work Index of Bulk Sample

The representative iron ore bulk sample was taken for grindability study as per Bond's method. The size analysis of the crushed product for grindability study was carried and the results are given in the Table 3.5. It was found that d_{80} of the feed material was 2100 micron. The grindability study was carried for 100 micron test sieve. The weight of the 700 cc of material was 1610 gm. For 250 percent circulating load, 460 gm of -100 micron particles are to be produced at equilibrium revolution. To reach the equilibrium revolution a number of tests were carried out. At the equilibrium stage, G_{bp} was 1.867.

The size analysis of -100 micron product was carried out. The size analysis of product is given in the Table 3.6. The overall grindability result of bulk Sample is given in Table 3.7. The particle size distribution of feed and product is depicted in Fig. 3.2 and 3.3 respectively. The d_{80} of the ball mill product was 79.5 micron. Then according to Equation, W.I. was calculated and it was found 10.2 kWh/short ton. It was converted to normal tonne and WI value is 11.3 kWh/tonne.

$Wi = (44.5)/((P_1)^{0.23} \times (Gbp)^{0.82}\,(10/\sqrt{P} - 10/\sqrt{F}))$

$=(44.5)/((100)^{0.23} \times (1.867)^{0.82}\,(10/\sqrt{79.5} - 10/\sqrt{2100}))$

= 10.2 kWh/short ton

= 10.2 X 1.1 = **11.5 kWh/tonne**

The bond work index of the sample is determined to be 11.5 kWh/tonne.

Table 3.5
Feed size analysis

Size, micron	Cum. Wt., % Passing
3360	100.00
2000	77.76
1000	52.80
850	40.25
500	31.68
300	25.09
212	17.27
150	12.80
100	9.69

Table 3.6
Size analysis of ground product

Size, micron	Cum Wt., % Passing
100	100.00
75	75.00
63	53.00
45	35.75
38	24.25

Table 3.7
Results of gram per revolution

No. of revolutions	100micron produced (g)	100micron in the feed (g)	Net -100micron produced (g)	Grindability (g/rev.)
100	398	156	242	2.420
174	410	38.6	371	2.130
197	420	39.7	380	1.926
218	448	40.7	407	1.868
223	460	43.4	417	1.866
223	461	44.6	416	1.869
222	460	44.7	415	1.867
223	460	44.6	415	1.865

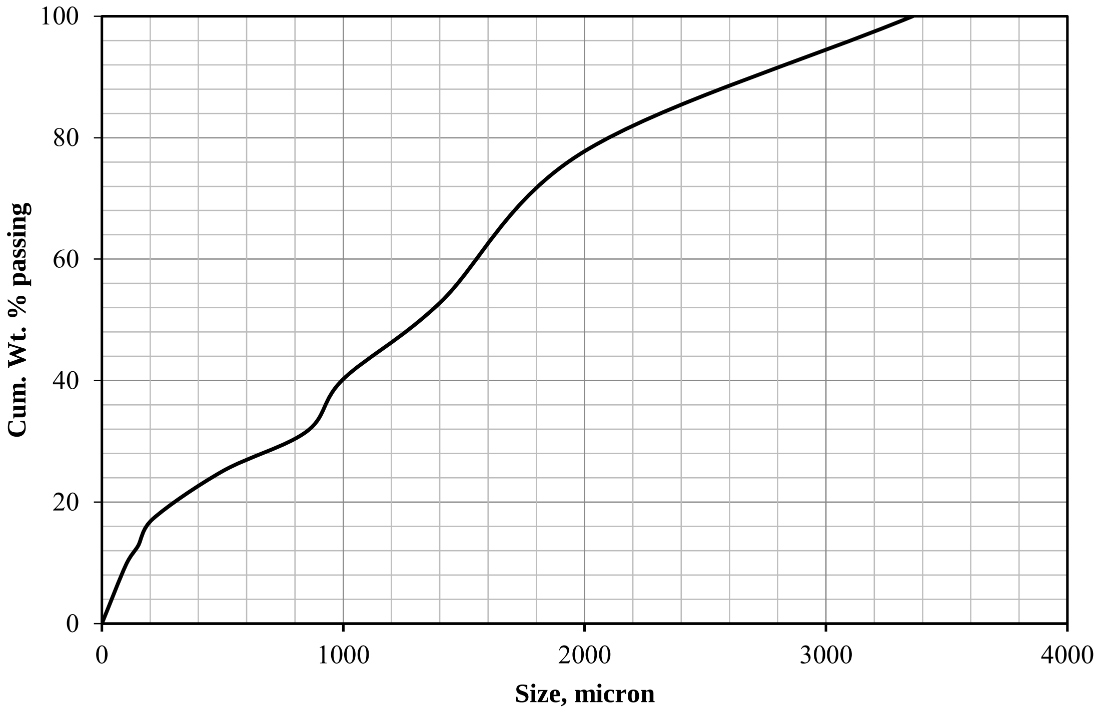


Fig. 3.2 Particle size distribution of feed

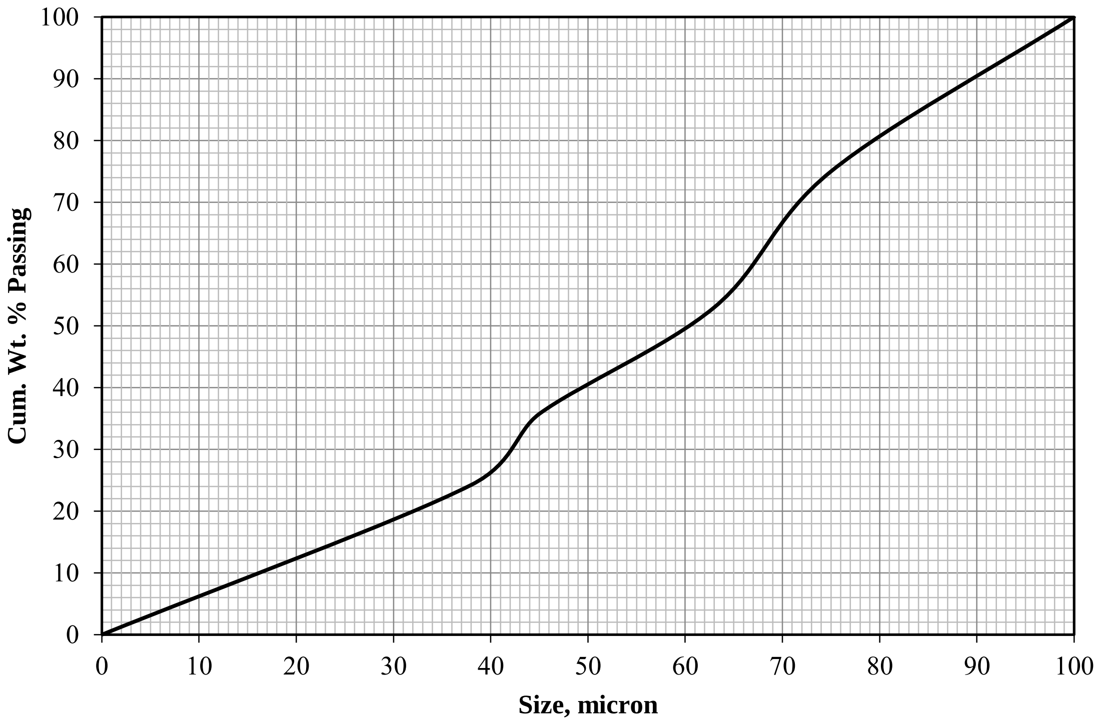


Fig. 3.3 Particle size distribution of product

3.5.4 Bond Work Index of Screw Scrubber Underflow Sample

The representative screw scrubber underflow sample was taken for grindability study as per Bond's method. The size analysis of the crushed product for grindability study was carried and the result is given in the Table 3.8. It was found that d_{80} of the feed material was 2030 micron. The grindability study was carried for 100 micron test sieve. The weight of the 700 cc of material was 1580 gm. For 250 percent circulating load, 452 gm of below 100 micron particles are to be produced at equilibrium revolution. To reach the equilibrium revolution a number of tests were carried out. At the equilibrium stage, G_{bp} was 1.647.

The size analysis of below 100 micron product was carried out. The size analysis of product is given in the Table 3.9. The overall grindability result of screw scrubber underflow is given in Table 3.10. The particle size description of feed and product is depicted in Fig. 3.4 and 3.5 respectively. The d_{80} of the ball mill product was 78.5 micron. Then according to equation, W.I. was calculated and it was found 11.3 kWh/short ton. It was converted to normal tonne and WI value is 12.4 kWh/tonne.

$$Wi = (44.5)/((P_1)^{0.23} \text{ X } (Gbp)^{0.82} (10/\sqrt{P} - 10/\sqrt{F}))$$

$$=(44.5)/((100)^{0.23} \text{ X } (1.647)^{0.82} (10/\sqrt{78.5} - 10/\sqrt{2030}))$$

$$= 11.3 \text{ kWh/short ton} = 11.3 \text{ X } 1.1 = \mathbf{12.4\ kWh/tonne}$$

The bond work index of the sample is determined to be 12.4 kWh/tonne.

Table 3.8
Feed size analysis

Size, micron	Cum. Wt., % Passing
3360	100.00
2000	79.24
1400	47.59
1000	32.15
850	21.90
500	15.32
212	8.86
150	5.95
100	4.18

Table 3.9

Size analysis of ground product

Size, micron	Cum Wt., % Passing
100	100.00
75	76.00
63	55.50
45	41.00
38	29.50

Table 3.10

Results of gram per revolution

No. of revolutions	100micron produced (g)	100micron in the feed (g)	Net -100micron produced (g)	Grindability (g/rev.)
100	268	66	202	2.020
218	604	11.2	593	2.717
157	488	25.2	463	2.947
146	316	20.4	296	2.019
217	396	13.2	383	1.762
247	428	16.6	411	1.665
261	450	17.9	432	1.658
261	450	18.8	431	1.651
262	451	18.8	432	1.647
263	451	18.9	432	1.644

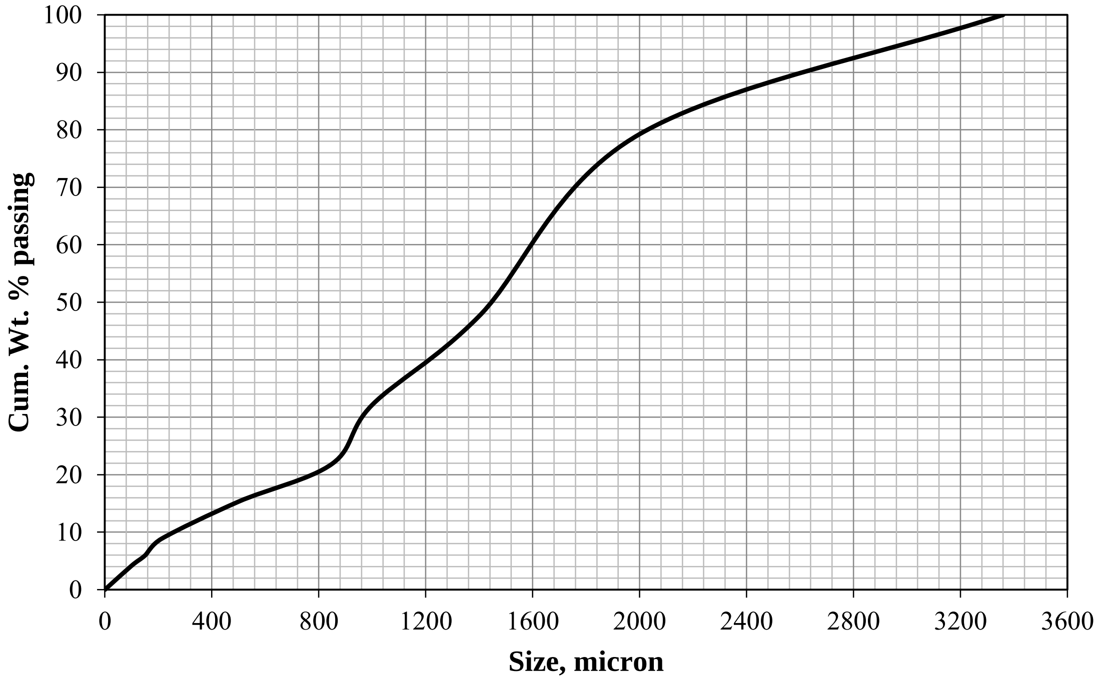


Fig. 3.4 Particle size distribution of feed

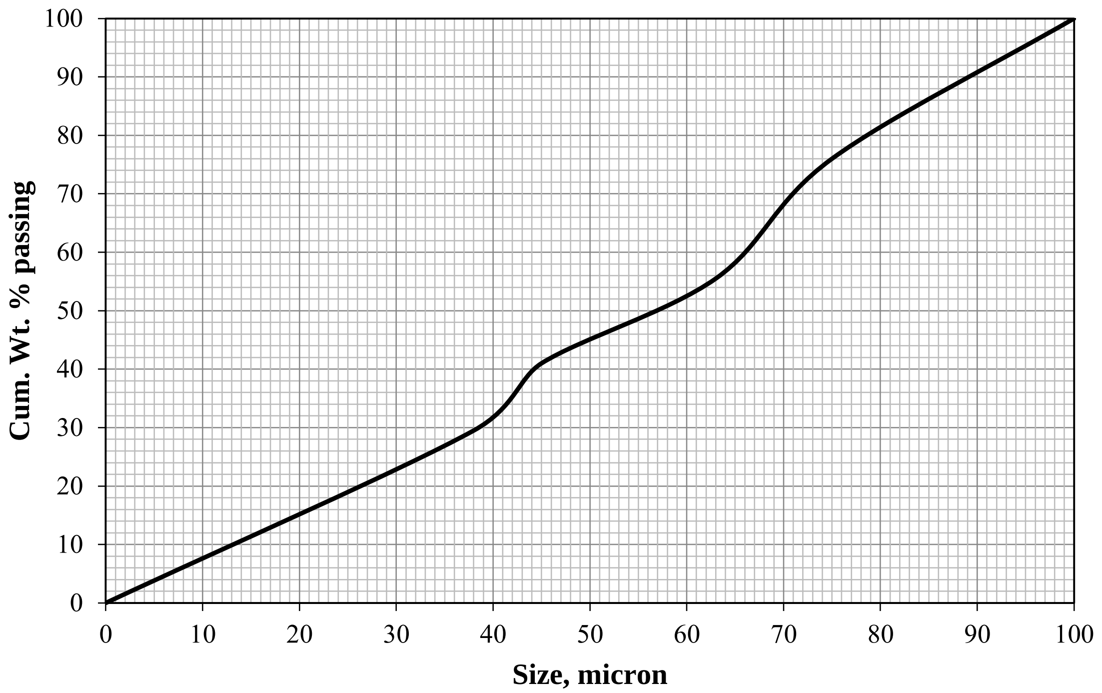


Fig. 3.5 Particle size distribution of product

3.6 Bulk Density

Bulk density is the weight of material in air per unit volume. It is measured by the help of a square sized metal container having length of each side 300 mm. Bulk density is evaluated by weighing a precisely measured known volume of ore sample. Natural moisture content is determined as per IS: 2720 (part 2) -1973. The bulk density of -10 mm sized sample is 1.982 kg/m^3 and its bulk density after being tapped is 3.178 kg/m^3.

3.7 Beneficiation Studies

The beneficiation study of the iron ore sample was carried out based on their mineralogy. According to size analysis studies, it contains good number of fine particles which may be iron phase minerals along with clay particles. In general, the fine clay particles are coated on the surface of the coarse particles. These clay minerals are responsible to increase the viscosity of slurry due to their swelling characteristics during the beneficiation process. Hence, it is essential to remove at the beginning of the process by scrubbing technique and discard as the reject. Hence the remaining materials can be processes smoothly for up-gradation of iron values by physical beneficiation. As it contains 12.96% of below 45 microns and the top size is below 10mm, hence for attrition of particles, screw scrubber process is most suitable. This equipment also classifies simultaneously the fine particles in a single stage. The laboratory screw scrubber was used for desliming the slime particles at the feed rate of 200 kg/hr using water to solid ratio of 70:30. The screw scrubber gives two products i.e., overflow (slimes) and underflow (coarse particles). The sample was fed to the screw scrubber. The Fe content of scrubber underflow could be achieved to 62.47% with overall yield of 80.90% and overflow fraction contained 53.61% Fe with overall yield of 19.10%. The result of screw scrubber is given in the Table 3.11. The result shows that screw scrubber underflow is one of the final product and overflow need to be further processed. Attempt was made to enhance the grade of scrubber underflow by further process.

Table 3.11
Screw scrubber study of bulk sample

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Underflow	80.90	80.90	62.47	62.47
Overflow	19.10	100.00	53.61	60.78
Total	100.00		60.78	

The underflow of screw scrubber was further classified into two different size fractions viz. (-10+1mm, and -1mm). The Fe content of -10+1 mm size could be achieved to 62.64% with overall yield of 59.42%. The Fe content of -1 mm size could be achieved to 62.01% with overall yield of 21.48%. The result of classified sample is given in Table 3.12. The result shows -10+1 mm is having slightly more higher Fe value compared to -1mm size fraction.

Table 3.12
Size classification of screw scrubber underflow

Size, mm	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
-10+1	59.42	59.42	62.64	62.64
-1	21.48	80.90	62.01	62.47
Total	80.90		62.47	

The -10+1 mm size fraction of sample was processed in the batch type laboratory jig (Supplied by All Minerals, Germany). In each batch around 50kg sample was taken during experiment. It is a hydraulic jig operated with pneumatic control pulsating system. The pulse frequency was kept 60 cycle per minute and air flow rate 0.3 to 0.4 bar. The screen aperture used for bed was 1 mm size. After 30 minutes the material was collected from the chamber in layer by layer from top to bottom at particular thickness. The concentrate (Layer 1, Layer 2 and Layer 3) obtained by jigging of -10+1 mm fraction contains 63.19% Fe with yield of 65.79% and tailings contains 55.40% Fe with yield of 4.94 %. The jigging study of -10+1 mm sample is given in the Table 3.13.

Table 3.13
Jigging study on -10+1 mm size fraction material

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Layer 1	51.93	51.93	64.14	64.14
Layer 2	7.49	59.42	60.23	63.65
Layer 3	6.37	65.79	58.89	63.19
Layer 4	4.94	70.73	55.40	62.64
Total	59.42		62.44	

The -1 mm size samples was processed in the spiral concentrator. Roughing and cleaning operations were carried out to enrich the concentrate grade. In both operations of roughing and scavenging, 30% solid concentration was maintained. The capacity of spiral concentrator is 1 tonne per hour. The Fe content of rougher concentrate could be achieved to 63.22% with overall yield of 18.13%. The Fe contains of scavenging concentrate, scavenging tailings and tailing fines could achieved 60.18%, 59.17% and 52.33% with overall yield of 3.36 %, 2.53 % 0.90% respectively. The result of spiral concentrator is given in the Table 3.14.

Table 3.14
Spiral study of -1mm size fraction material

Details	Wt., %	Cum Wt., %	Fe, %	Cum. Fe, %
Rougher Concentrate	18.13	18.13	63.22	63.22
Scavenging Concentrate	3.36	21.48	60.18	62.75
Scavenging Tailings	2.53	24.01	59.17	62.37
Tailing Fines	0.90	24.91	52.33	62.01
Total	21.48		62.01	

The -10+1 mm size was further classified in two different size fractions viz. (-10+5 mm, and -5+1mm). The Fe content of -10+5 mm size could be achieved to 63.12% with overall yield of 30.17%. The Fe content of -5+1 mm size could be achieved to 62.14% with overall yield of 29.25 %. The result of classified sample is given in Table 3.15.

Table 3.15
Size classification of -10+1 mm fraction

Size, mm	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
-10+5	30.17	30.17	63.12	63.12
-5+1	29.25	59.42	62.14	62.64
Total	59.42		62.64	

The -10+5 mm and -5+1 mm size fraction of samples were processed in the batch type laboratory jig. In each batch around 50kg sample was taken for experiment. The pulse frequency was kept 60 cycle per minute and air flow rate 0.3 to 0.4 bar. The screen aperture used for bed was 1 mm size. After 30 minute the material was collected from the chamber in layers from top to bottom at particular thickness. The concentrate (Layer 1, Layer 2 and Layer 3) obtained by jigging of -10+5 mm fraction contains 62.74% Fe with yield of 28.06% and tailings contains 53.23% Fe with yield of 2.11%. The jigging study of -10+5 mm sample is given in Table 3.16. The concentrates (Layer 1, Layer 2 and Layer 3) obtained by jigging of -5+1 mm fraction contains 62.74 % Fe with yield of 27.41 % and tailings contains 53.23% Fe with yield of 1.84%. The jigging study of -5+1 mm sample is given in Table 3.17.

Table 3.16
Jigging study on -10+5 mm size fraction material

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Layer 1	22.15	22.15	64.12	64.12
Layer 2	3.19	25.35	60.08	63.26
Layer 3	2.72	28.06	59.07	62.74
Layer 4	2.11	30.17	53.23	62.14
Total	30.17		62.14	

Table 3.17
Jigging study on -5+1 mm size fraction material

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Layer 1	18.89	18.89	64.12	64.12
Layer 2	5.09	23.98	60.08	63.26
Layer 3	3.43	27.41	59.07	62.74
Layer 4	1.84	29.25	53.23	62.14
Total	29.25		62.14	

The overflow of screw scrubber is to be deslimed by hydrocyclone to remove the ultrafine gangue minerals directly. The screw scrubber overflow sample was fed to the rougher hydrocyclone. The hydrocyclone gives two products i.e., overflow (very ultrafine slimes particle) and underflow (fine coarse particles). The Fe content of hydrocyclone underflow could be achieved to 57.52% Fe with overall yield of 11.33% and overflow fraction contained 47.90% Fe with overall yield of 7.77%. The rougher hydrocyclone overflow sample was fed to the scavenging hydrocyclone at the density 1040 kg/m^3. The Fe content of scavenger hydrocyclone underflow could be achieved to 54.45% Fe with overall yield of 1.26% and overflow fraction contained 46.63% Fe with overall yield of 6.51%. The rougher and scavenging hydrocyclone study are given in Table 3.18 and 3.19.

Table 3.18

Rougher hydrocyclone study of screw scrubber overflow

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Underflow	11.33	11.33	57.52	57.52
Overflow	7.77	19.10	47.90	53.61
Total	19.10		53.61	

Table 3.19

Scavenging hydrocyclone study

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Underflow	1.26	1.26	54.45	54.45
Overflow	6.51	7.77	46.63	47.90
Total	7.77		47.90	

If the overflow of hydrocyclone contains ultrafine hematite particles and are not the discardable, then the screw scrubber overflow will be beneficiated directly using WHIMS/HGMS.

The rougher and scavenging hydrocyclone underflow were blended together and given in Table 3.20. The blended material fed to LONGI. The intensity of magnetic separator (Longi) having 12000 gauss in pilot scale. The result of rougher LONGI study is given in the Table 3.21. The Fe content of the rougher magnetic fraction could be enhanced to 62.15% Fe with overall yield of 8.22%. The rougher middling could be achieved 57.44% Fe with overall Yield of 1.00 % and non-magnetic fraction from rougher tailings contains 45.10% Fe with overall yield of 3.37%. The rougher tailings of LONGI was further fed to scavenger stage of LONGI. The Fe content of the scavenging magnetic fraction could be enhanced to 56.39% Fe with overall yield of 1.00%. The scavenging middling contains 44.79% Fe with overall Yield of 0.26% and non-magnetic fraction from scavenging tailings contains 39.79%Fe with overall yield of 2.11%. The result of scavenger LONGI is given in the Table 3.22.

Table 3.20
Blending of hydrocyclone underflows

Details	Wt., %	Cum Wt., %	Fe, %	Cum. Fe, %
Rougher hydrocyclone underflow	11.33	11.33	57.52	57.52
Scavenging hydrocyclone underflow	1.26	12.59	54.45	57.21
Total	12.59		57.21	

Table 3.21
LONGI study of blended product

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Mag	8.22	8.22	62.15	62.15
Middling	1.00	9.22	57.44	61.64
Non-Mag	3.37	12.59	45.10	57.21
Total	12.59		57.21	

Table 3.22
LONGI scavenging study

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Mag	1.00	1.00	56.39	56.39
Middling	0.26	1.26	44.79	54.00
Non-Mag	2.11	3.37	39.79	45.10
Total	3.37		45.10	

The overflow of hydrocyclone was fed to HGMS (supplied by LONGI). The magnetic intensity of LONGI is 12000 gauss. The feed density was kept at 1.06 kg/m^3. The Fe content of the rougher magnetic fraction of LONGI could be achieved to 57.78 % Fe with overall yield of 1.81% whereas non-magnetic fraction contains 41.58% Fe with overall yield of 4.24 %. The rougher non-magnetic fraction was fed to the scavenging LONGI. The Fe content of the scavenging magnetic fraction of LONGI could be achieved to 43.21% Fe with overall yield of 0.82% and non-magnetic fraction contains 41.12% Fe with overall yield of 3.06%. The rougher and scavenging magnetic separation results are given in Table 3.23 and 3.24.

Table 3.23
LONGI study of hydrocyclone overflow

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Mag	1.81	1.81	57.78	57.78
Middling	0.46	2.27	49.28	56.06
Non-Mag	4.24	6.51	41.58	46.63
Total	6.51		46.63	

Table 3.24
LONGI scavenging study

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Mag	0.82	0.82	43.21	43.21
Middling	0.35	1.18	41.76	42.78
Non-Mag	3.06	4.24	41.12	41.58
Total	4.24		41.58	

Based on the above study and considering on the quality and quantity on the final product, following process were carried out. The beneficiation study was carried out by using screw scrubbing of the ROM sample followed by the Magnetic separation of the screw scrubber overflow and scavenging magnetic separation of rougher non-magnetic fraction. The results are given in the Table 3.25 to Table 3.27. The overall product is given in the Table 3.28 and the overall reject is given in the Table 3.29. The process flowsheet is shown in Figure 3.7. The chemical analysis of the product and reject are given in Table 3.30 and 3.31 respectively.

Table 3.25
Scrubbing study of bulk sample

Details	Wt., %	Cum Wt., %	Fe, %	Cum. Fe, %
Underflow	80.90	80.90	62.47	62.47
Overflow	19.10	100.00	53.61	60.78
Total	100.00		60.78	

Table 3.26
Rougher magnetic separation study of screw scrubber overflow

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Mag	10.03	10.03	61.36	61.36
Middling	1.46	11.49	54.87	60.54
Non-Mag	7.61	19.10	43.14	53.60
Total	19.10		53.61	

Table 3.26
Rougher magnetic separation study of screw scrubber overflow

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Mag	8.22	8.22	62.15	62.15
Middling	1.46	9.68	55.87	61.18
Non-Mag	9.42	19.10	45.80	53.61
Total	19.10		53.61	

Table 3.27
Scavenging magnetic separation study of rougher non-magnetic fraction

Details	Wt., %	Cum. Wt., %	Fe, %	Cum. Fe, %
Mag	2.81	2.81	58.66	58.66
Middling	0.61	3.42	45.66	56.34
Non-Mag	7.46	10.88	42.94	47.15
Total	10.88		47.15	

Table 3.28
Overall products

Details	Wt., %	Fe, %
Screw Scrubber underflow	80.90	62.47
Rougher MS Conc.	8.22	62.15
Scavenger MS Conc.	2.81	58.66
Total	91.93	62.32

Table 3.29
Overall rejects

Details	Wt., %	Fe, %
Scavenger Middling	0.61	45.66
Scavenger Tailings	7.46	42.94
Total	8.07	43.15

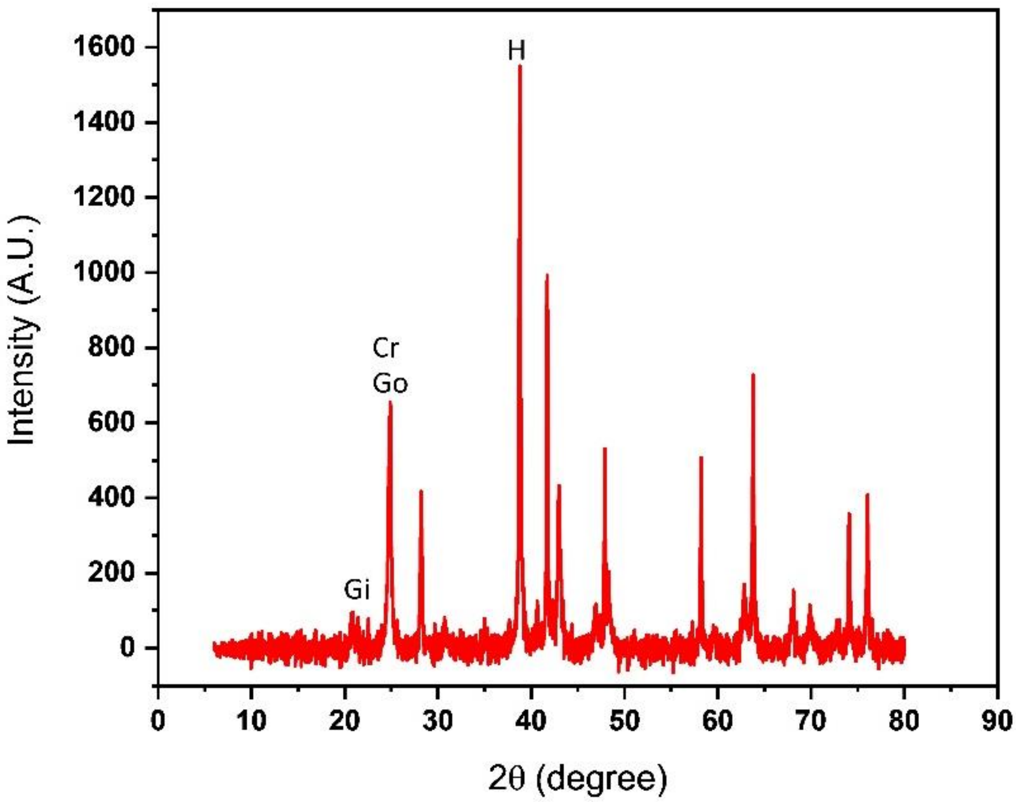
Table 3.30
Chemical analysis of the product

Details	Scrubber Underflow	Rougher Mag.	Scavenger Mag.	Overall Product
Fe (T)	62.47	62.15	58.66	62.32
Fe_2O_3	89.33	88.87	83.88	89.12
SiO_2	1.75	1.9	3.29	1.81
Al_2O_3	2.74	3.41	6.58	2.92
LOI	5.85	5.79	6.23	5.86

Table 3.31
Chemical analysis of the reject

Details	Percentage
Fe (T)	43.00
Fe_2O_3	61.49
SiO_2	13.72
Al_2O_3	17.70
LOI	7.01

XRD study was carried out on the product sample to determine the major minerals present in the samples. The XRD results is shown in Fig. 3.6. It indicates that the product sample have hematite as the major mineral phase and other minor minerals are quartz, goethite, cristobilite and quartz.



H: Hematite, Go: Goethite, Gi: Gibbsite, Cr: Cristobilite

Fig. 3.6 XRD study of product sample

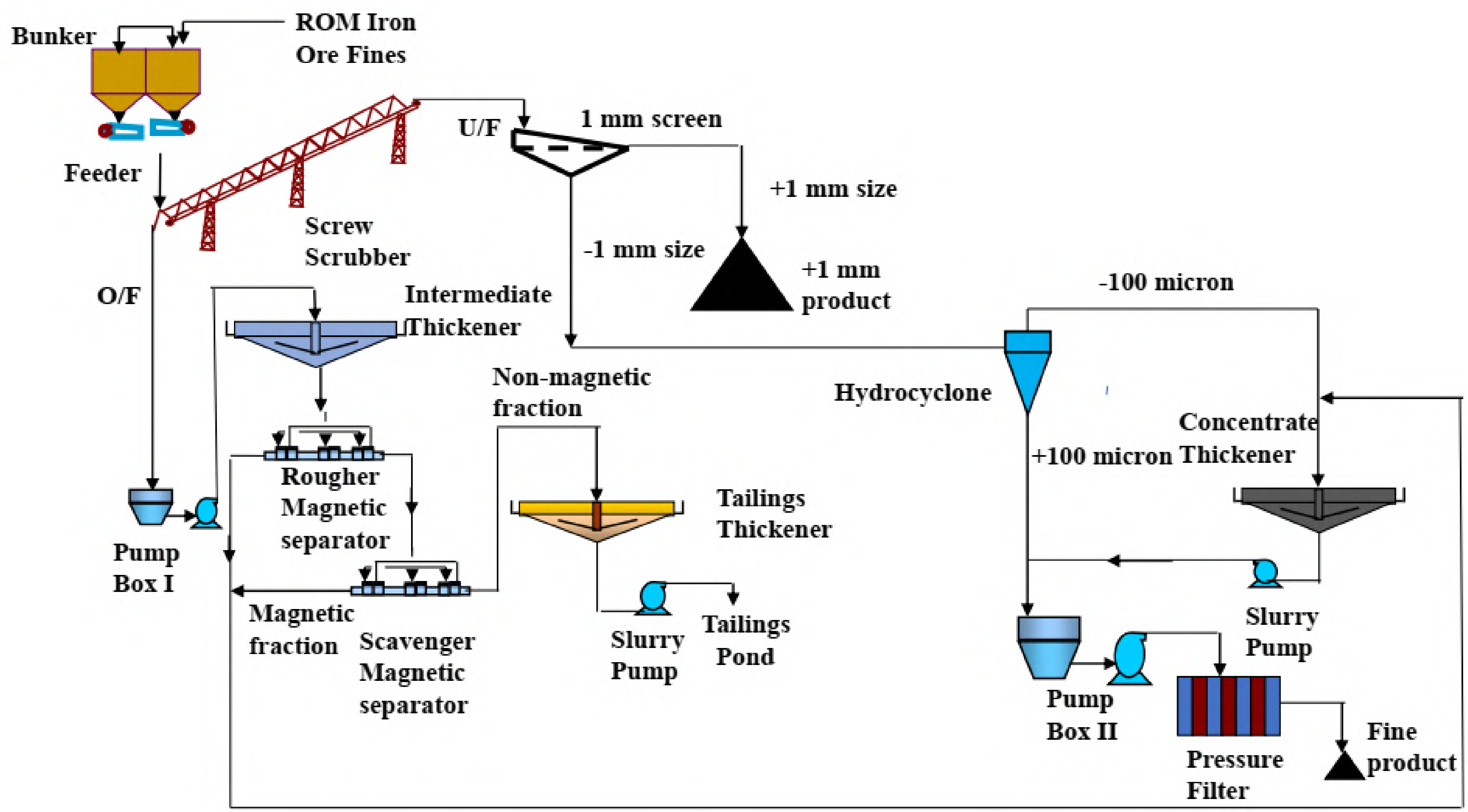


Fig. 3.7 Process flowsheet for washing of low-grade iron ore of Narayanposhi

3.8 Pressure Filtration Study

The pressure filtration study of magnetic separation concentrate and tailings were carried out by using Diemme Filter press and the results are given in Table 3.32 and 3.33. The pressure filter used for experiment is shown in Fig. 3.8.

Fig. 3.8 Pilot scale pressure filter set up

Table 3.32
Pressure filtration result of magnetic separation concentrate

Parameters	Exp. 1
Solid % in feed	60
Feeding time, min	15
Feeding pressure, bar	6
Air purging time, min	7.5
Air purging pressure, bar	8
Squeezing time, min	7.5
Squeezing pressure, bar	11
Total filtration time, min	30
Weight of cake (Wet), Kg	45.5
Cake Thickness, mm	20
Filtrate (water)	30
Cake moisture, %	17.2

Table 3.33
Pressure filtration result of magnetic separation tailings

Parameters	Exp. 1
Solid % in feed	32
Feeding time, min	15
Feeding pressure, bar	7
Air purging time, min	10
Air purging pressure, bar	8
Squeezing time, min	10
Squeezing pressure, bar	13
Total filtration time, min	35
Cake Thickness, mm	18.0
Cake moisture, %	21.8

3.9 Settling Studies

3.9.1 Materials Preparation

After processing of the iron ore, the tailing and concentrate samples were taken for the settling study to provide the basic data for design of thickeners for tailings and concentrate.

3.9.2 Experimental Method

The settling study was carried out in a graduated measuring cylinder of 1 liter capacity. Different solid concentration like 20% to 30% in increment of 5% of concentrate and 5% to 10% in the increment of 2.5% tailing samples are prepared. The pH of the concentrate sample was maintained at 6.5 and the pH of tailing is also 6.5. This is due to pH as the received in the process. The interface height was observed against the time intervals. The interface level with respect to time was recorded in each case.

3.9.3 Results and Discussion

The settling study was carried out on concentrate sample at different solids concentration of 20%, 25% and 30%. The pH of the sample was kept at 6.5 as the sample was received from the process at the same pH. The results of experiments were shown in Figures 3.9 to 3.12. It has been observed that the settling rate decreases with increasing of solid percentage. In case of 20% of solid concentration, the settling rate is 1.5 m/hr. Different dosses of flocculent was used to enhance the settling rate of solid. Very low doses of flocculent is required at lower solid concentration to get satisfactory results to design the conventional thickener. At higher solid concentration, the flocculent dosage requirement is little high.

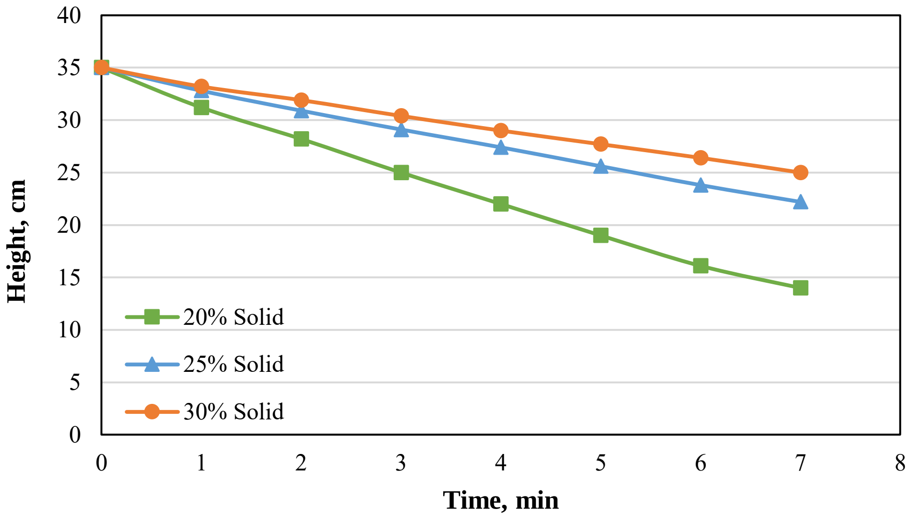


Fig. 3.9 Settling study of iron ore concentrate at different solid concentration

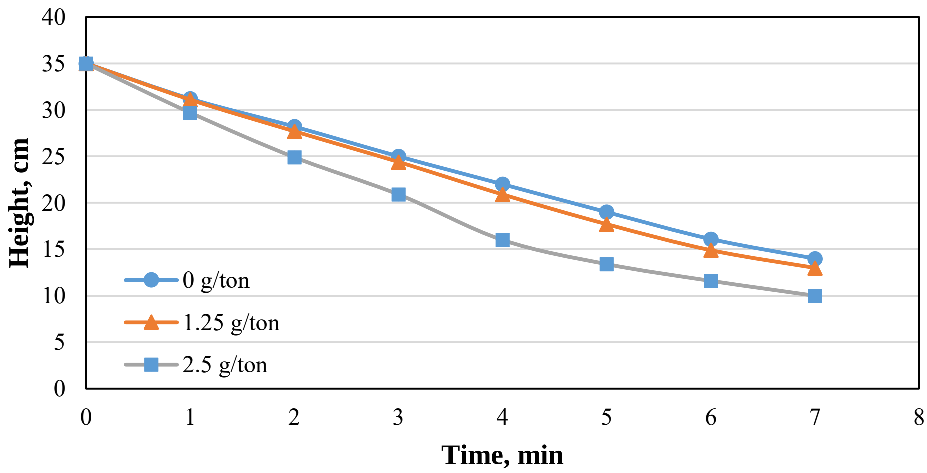


Fig. 3.10 Iron ore concentrate settling study at 20% solid concentration with different doses of flocculent

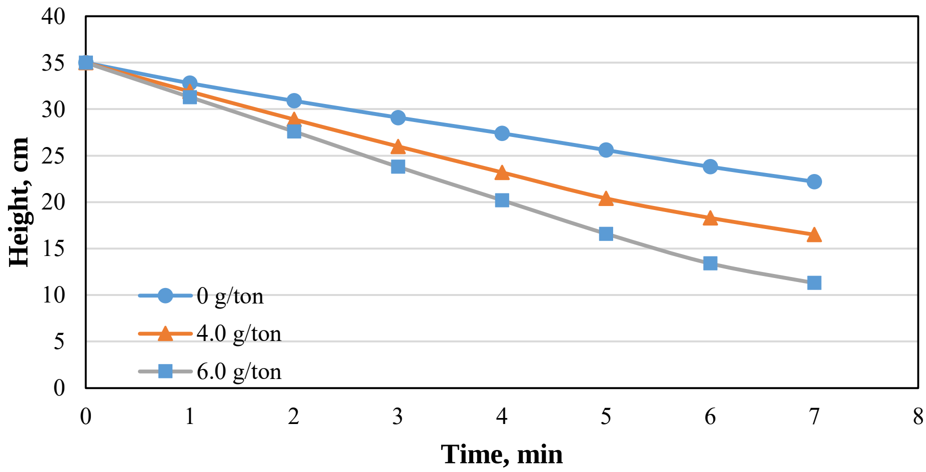


Fig. 3.11 Iron ore concentrate settling study of 25% solid concentration with different doses of flocculent.

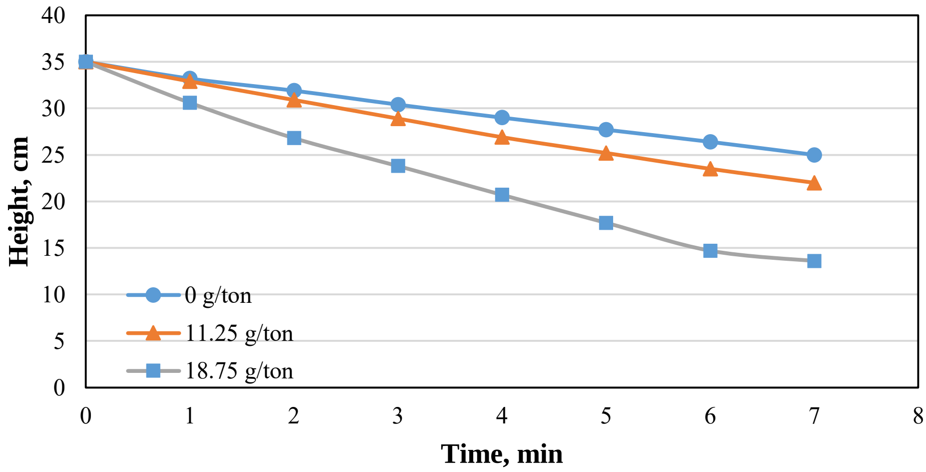


Fig. 3.12 Iron ore concentrate settling study of 30% solid concentration with different doses of flocculent.

Similarly settling studies of iron ore tailings were carried out at different concentration of 5%, 7.5% and 10%. The tests were carried out without and with addition of flocculent. The tests results are shown in Figure 3.13 to 3.16. It has been observed that the settling rate decreases with increasing of solid percentage. In case of 5% of solid concentration, the settling rate is 2 m/hr whereas in case 15 %, the settling rate is 0.8 m/hr. The flocculent rate was varied from 6.52 gm/tonne to 30 gm/tonne of solid. The settling rate with flocculent is very high at lower solid concentration. It indicates that after 5% solid concentration, the flocculent may require at lower dosage to enhance the settling rate. At higher solid concentration, the flocculent dosage requirement is high. At 10% solid concentration, the settling rate is very poor even after adding the flocculent.

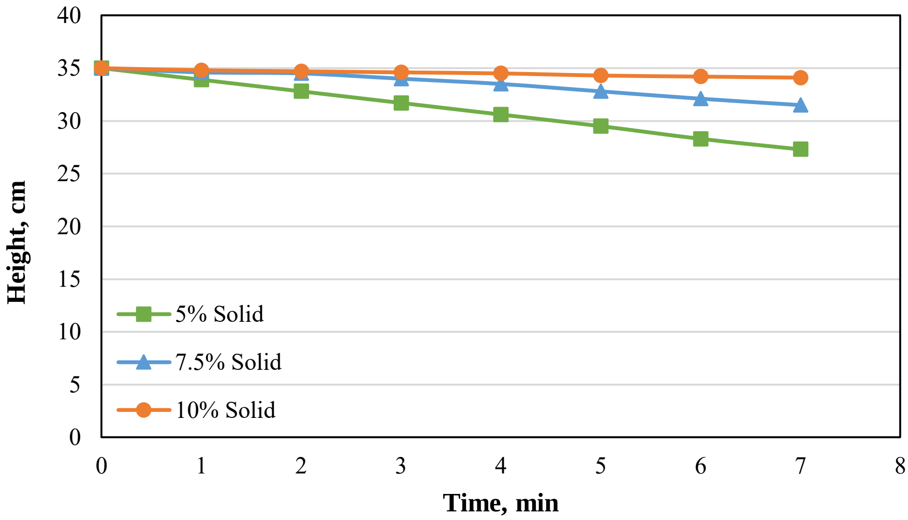


Fig. 3.13 Iron ore tailings settling study of different solid concentration

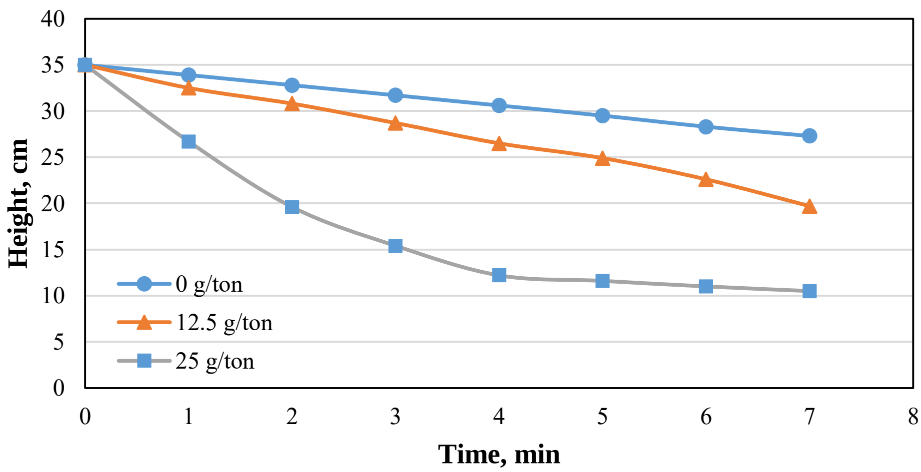


Fig. 3.14 Iron ore tailings settling study at 5% solid concentration with different doses of flocculent

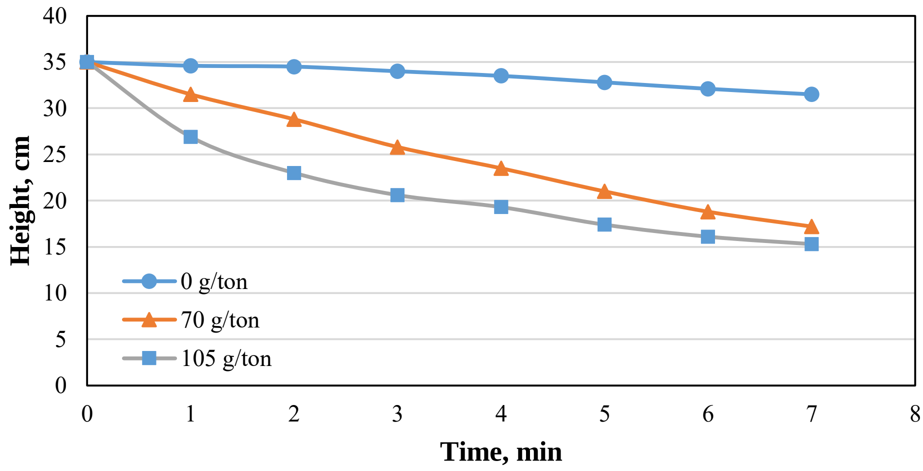


Fig. 3.15 Iron ore tailings settling study at 7.5% solid concentration with different doses of flocculent

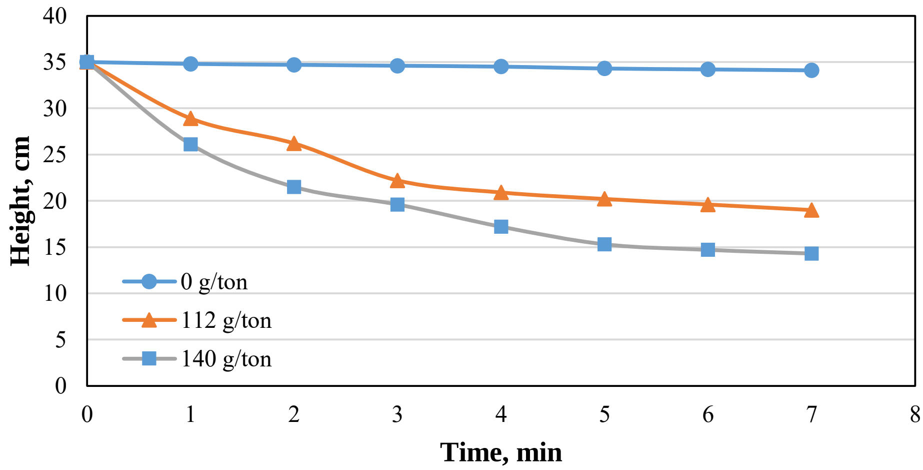


Fig. 3.16 Iron ore tailings settling study at 10% solid concentration with different doses of flocculent

3.10 Conclusions

The results of settling studies indicate the following observations;

1. The settling rate in case of tailings sample is very slow due to presence of ultra-fine clay minerals. Because of its surface charge, those try to remain in dispersion mode. The flocculent helps to neutralize the surface charge and make agglomerates the ultra-fine particles, as a result, the settling rate enhances.

2. The settling rate for conventional thickener design is required around 20 cm within 5-6 minutes. The above results are matching these phenomena.
3. For concentrate sample, small dose of flocculants was required to be added as there was less clay mineral compared to the tailings.

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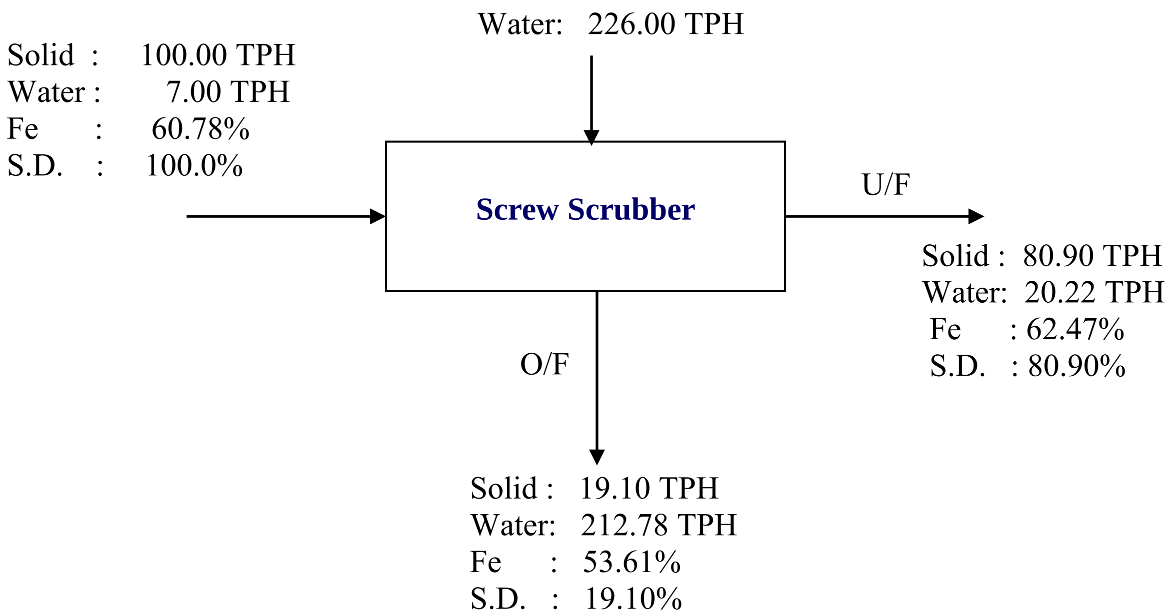
Annexure II.A

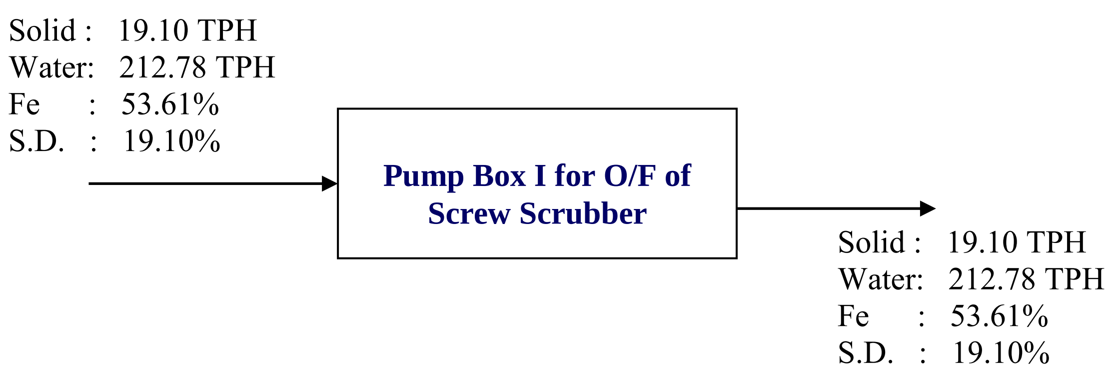
Material Balance of Process (Narayanposhi Iron ore)

Basis: 100 TPH

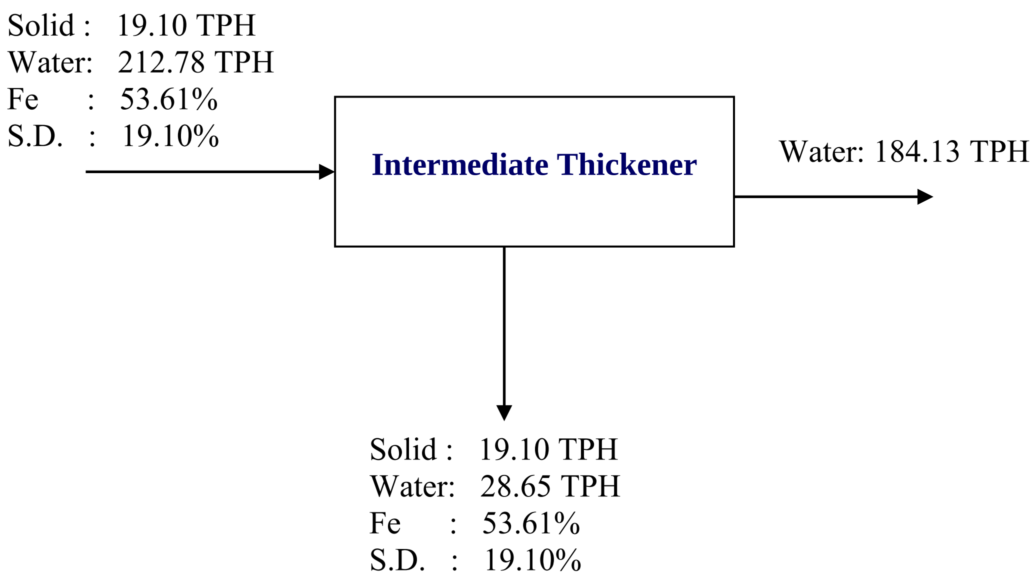
1. Screw Scrubber



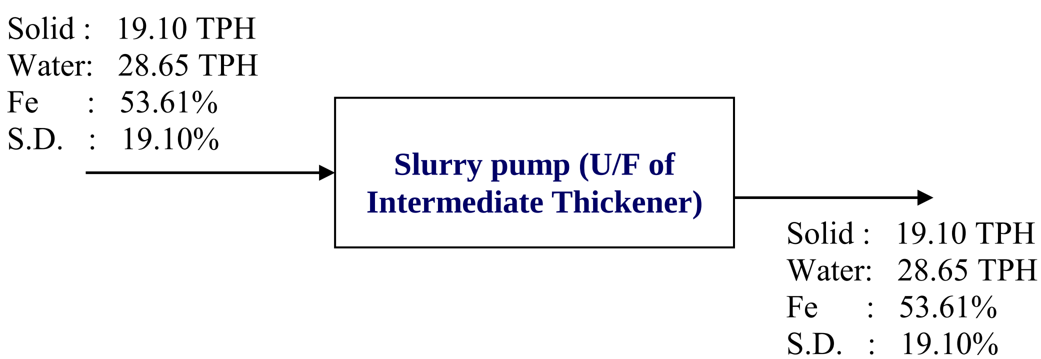
2. Pump Box I (O/F of Screw Scrubber)



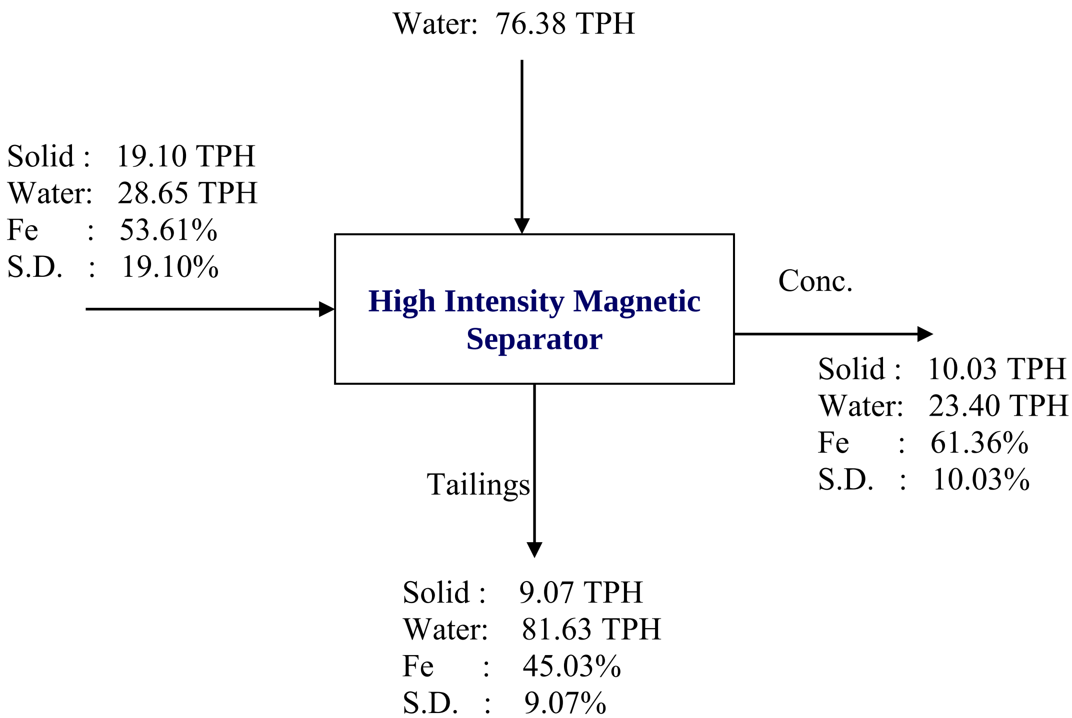
3. Intermediate Thickener



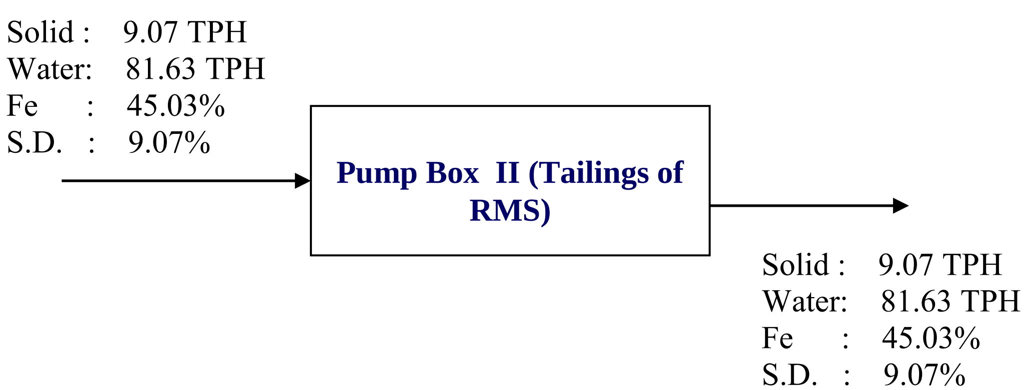
4. Slurry Pump I (U/F of intermediate thickener)



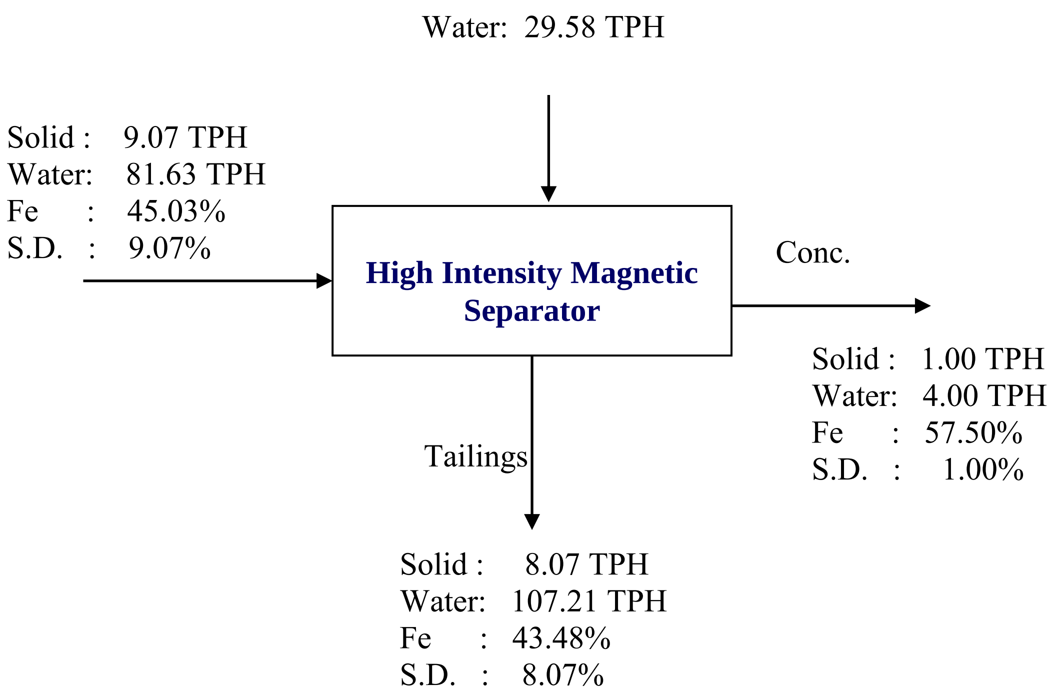
5. High Intensity Rougher Magnetic Separator



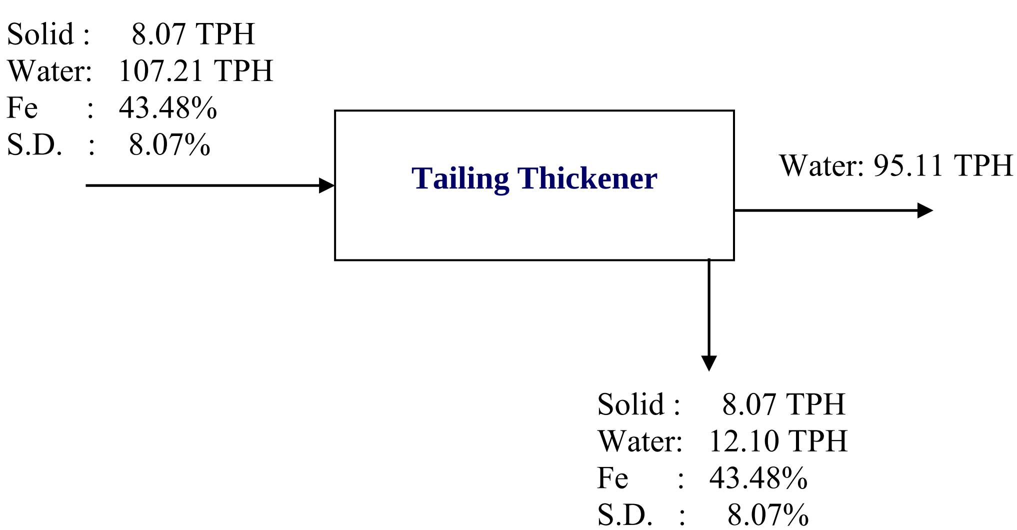
6. Pump Box II (Tailings of RMS)



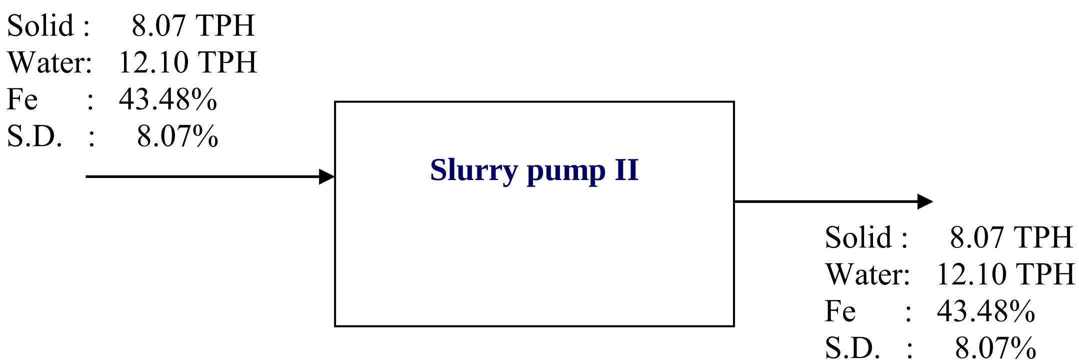
7. High Intensity Scavenging Magnetic Separator



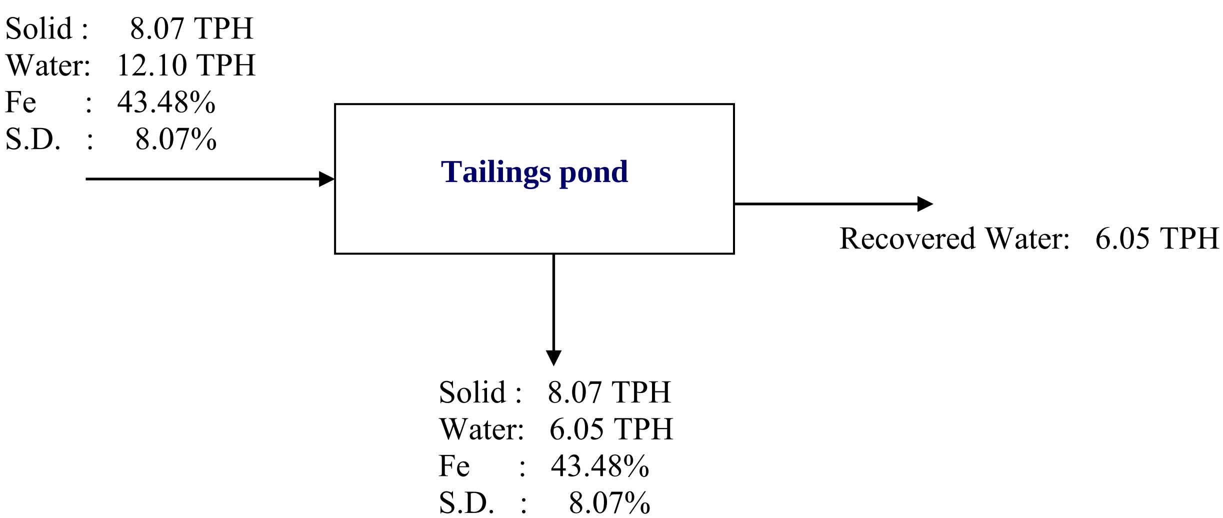
8. Tailing Thickener



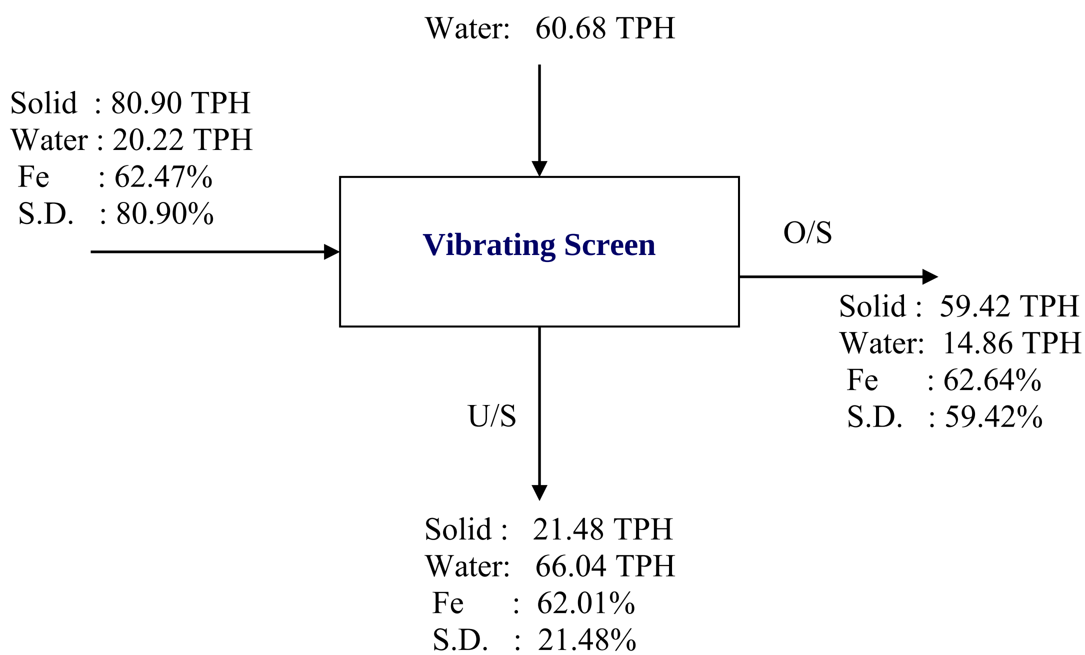
9. Slurry Pump II



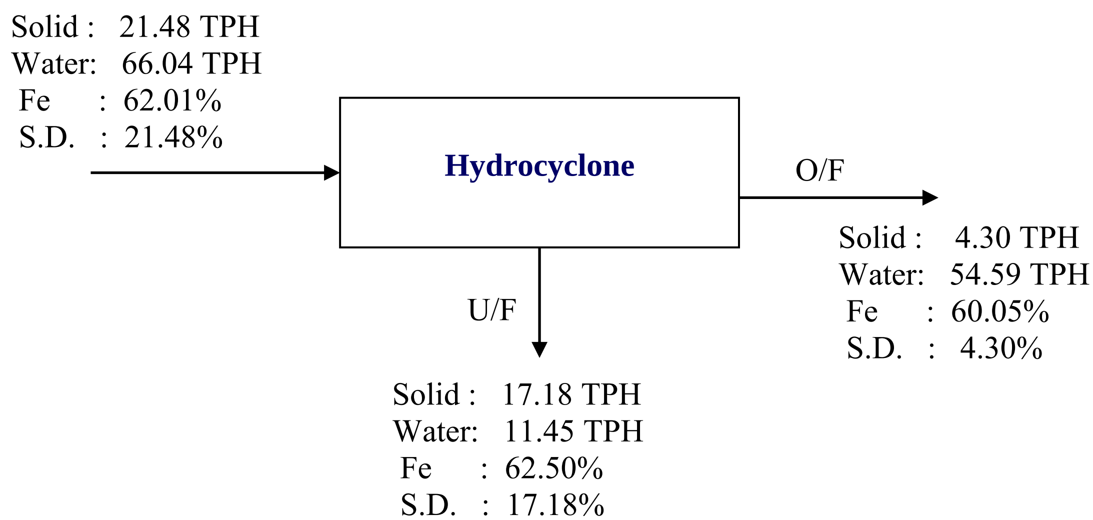
10. Tailings Pond



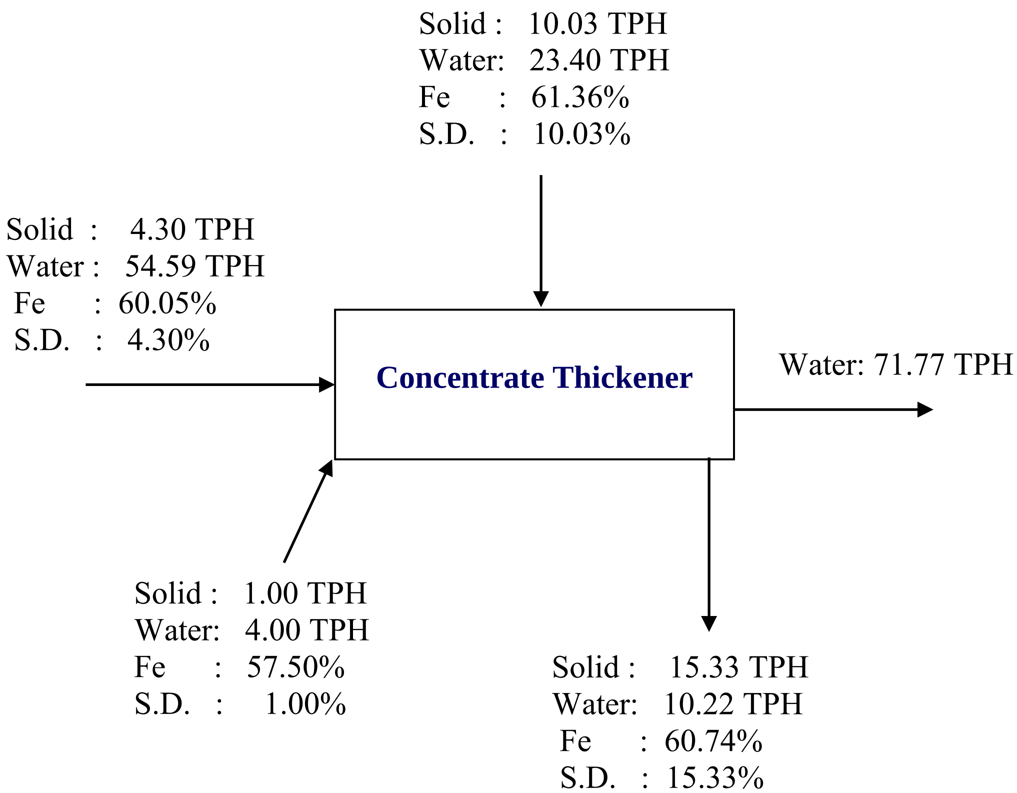
11. Vibrating Screen (1 mm size)



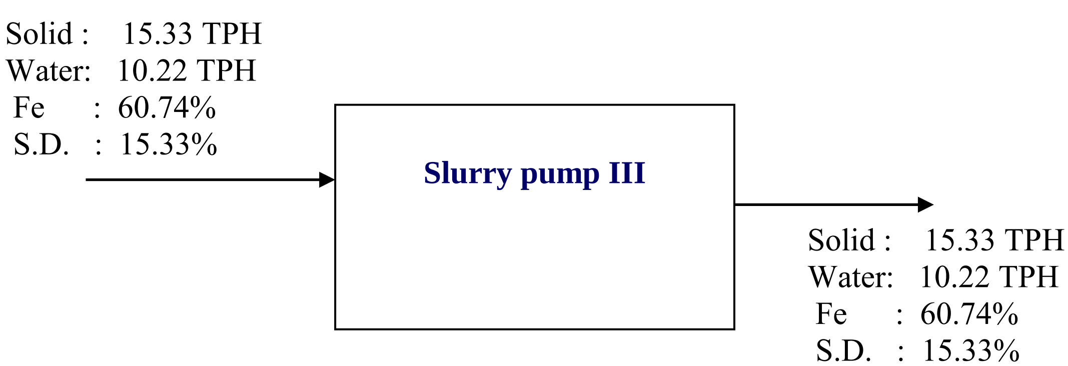
12. Hydrocyclone



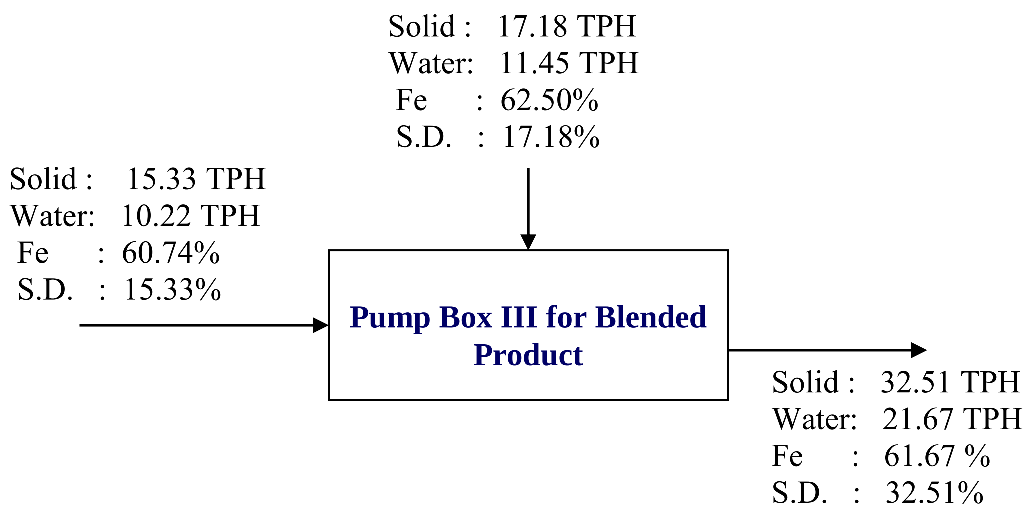
13. Concentrate Thickener



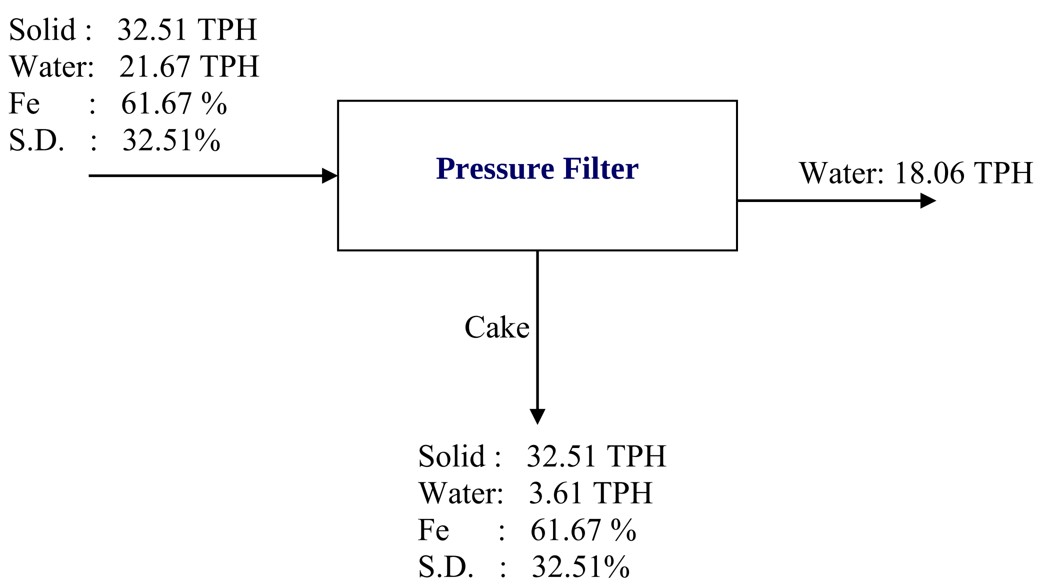
14. Slurry Pump III (Underflow of CT)



15. Pump Box III (Blended Product)



16. Pressure Filter



Water Balance

A. Water Handling

Sl. No.	List of Equipment	Water Addition, TPH
1	Bulk Sample	7.00
2	Screw Scrubber	226.00
3	Vibrating Screen	60.68
4	Rougher Magnetic Separator	76.38
5	Scavenger Magnetic Separator	29.58
Total		**399.64**

B. Water Recovered

Sl. No.	List of Equipment	Water recovered, TPH
1	Intermediate Thickener	184.13
2	Concentrate Thickener	71.77
3	Pressure Filter	18.06
4	Tailings Thickener	95.11
5	Tailing Pond	6.05
Total		**375.12**

C. Water Contains in Products

Sl. No.	Name of the Product	Water Contain, TPH
1	Pressure Filter	3.61
2	Vibrating screen	14.86
3	Tailing pond	6.05
Total		**24.52**

D. Make up water

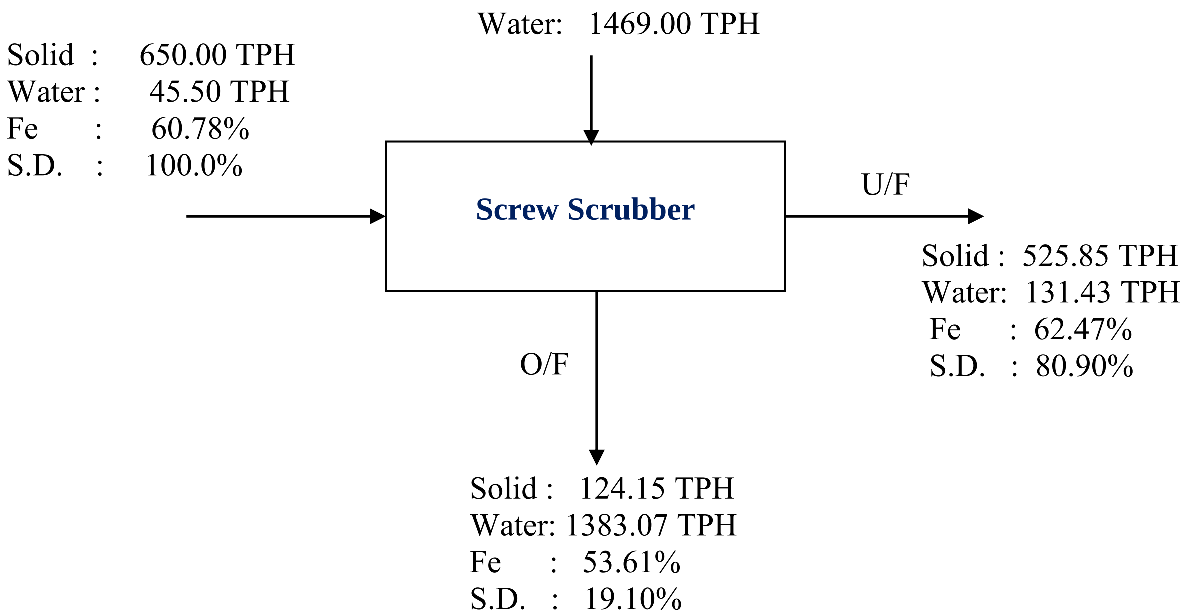
Sl. No.	Name of the Product	Water Contain, TPH
1	Water content in products	18.47
2	Water content in tailings	6.05
3	1% of handling loss	4.00
Total		**28.52**

Annexure II.B

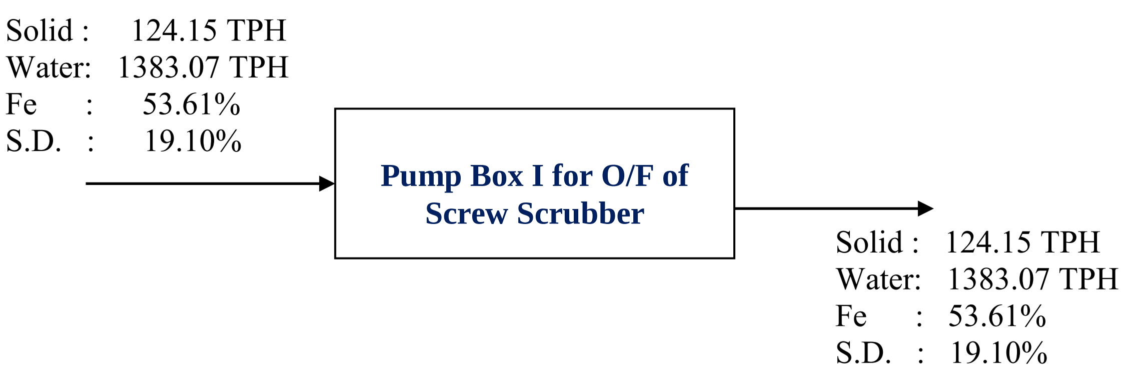
Material Balance of Process (Narayanposhi Iron ore)

Basis: 650 TPH

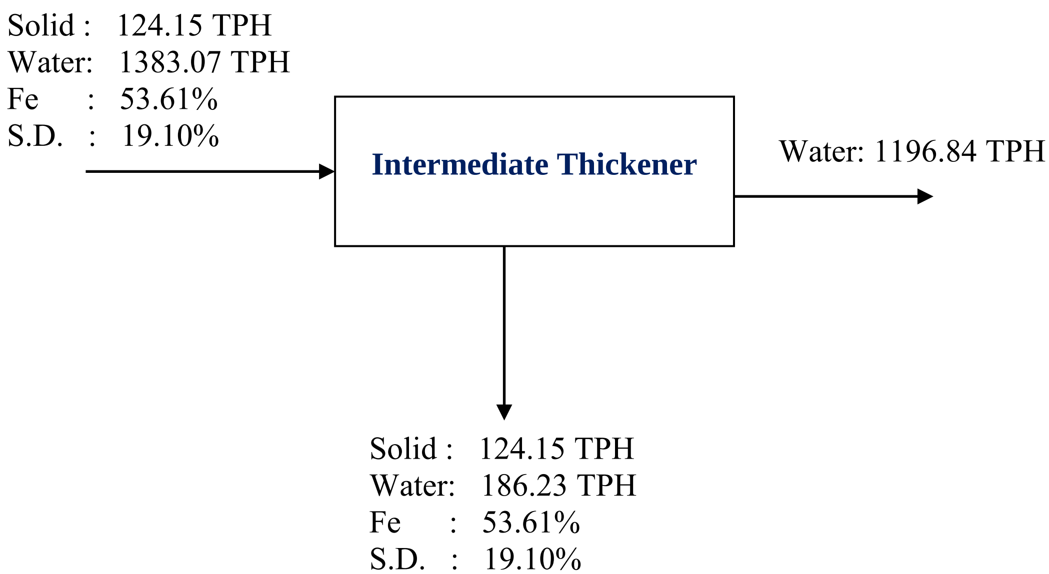
1. Screw Scrubber



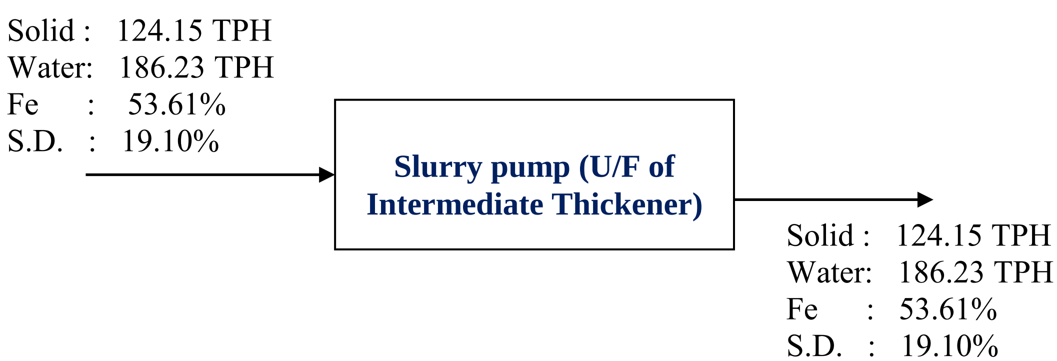
2. Pump Box I (O/F of Screw Scrubber)



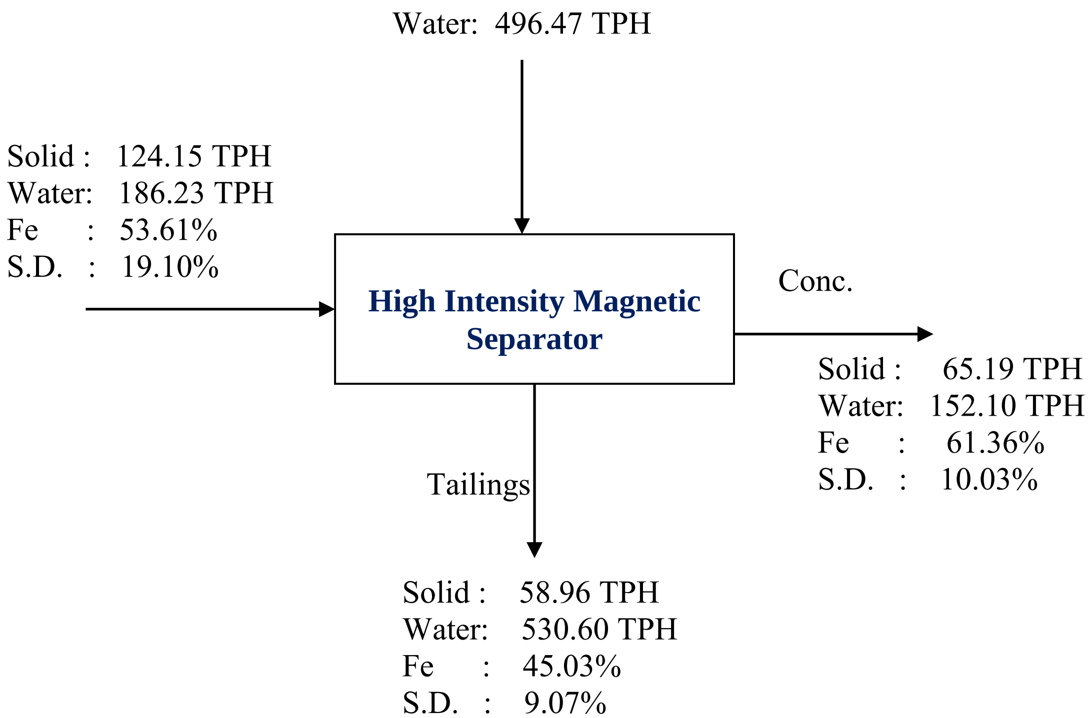
3. Intermediate Thickener



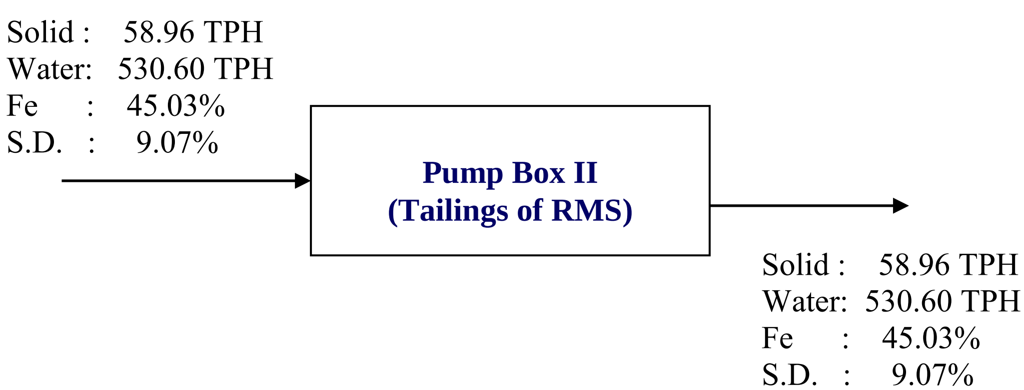
4. Slurry Pump I (U/F of intermediate thickener)



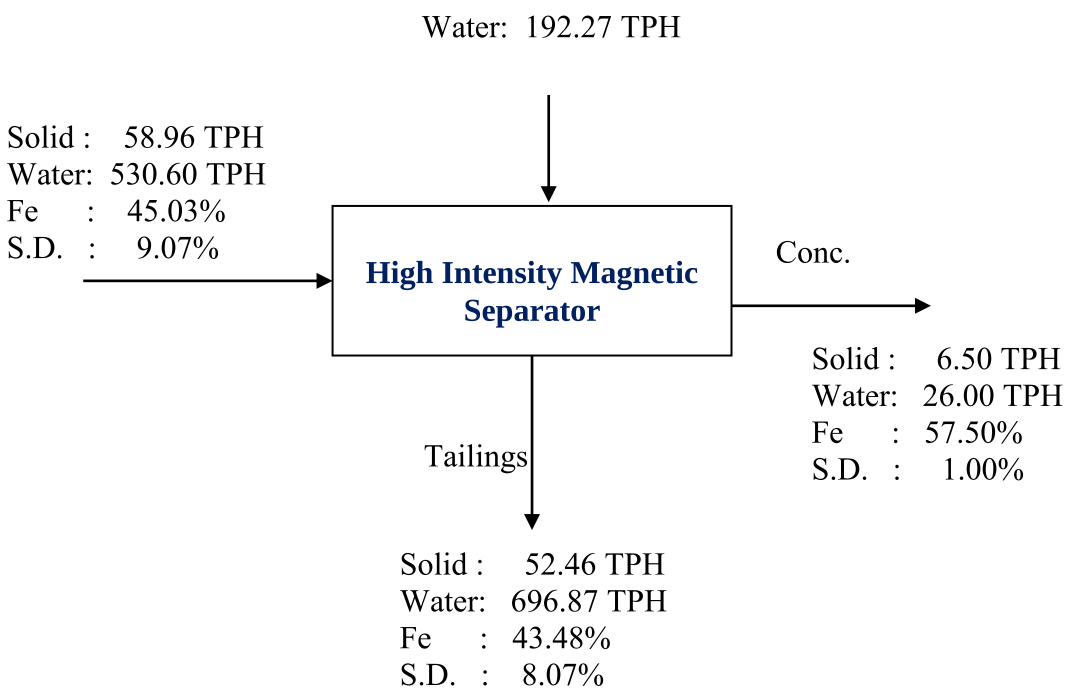
5. High Intensity Rougher Magnetic Separator



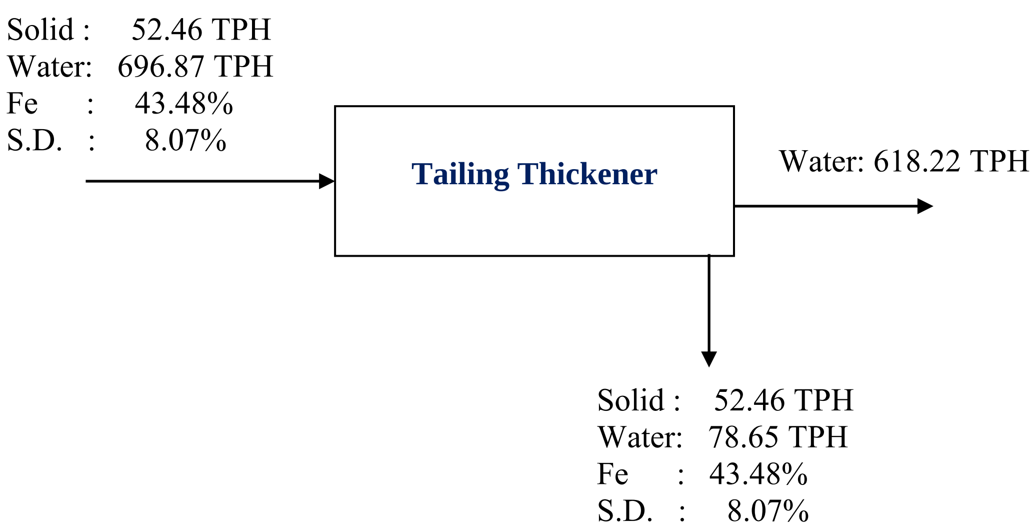
6. Pump Box II (Tailings of RMS)



7. High Intensity Scavenging Magnetic Separator



8. Tailing Thickener



9. Slurry Pump II

Solid : 52.46 TPH
Water: 78.65 TPH
Fe : 43.48%
S.D. : 8.07%

Slurry pump II

Solid : 52.46 TPH
Water: 78.65 TPH
Fe : 43.48%
S.D. : 8.07%

10. Tailings Pond

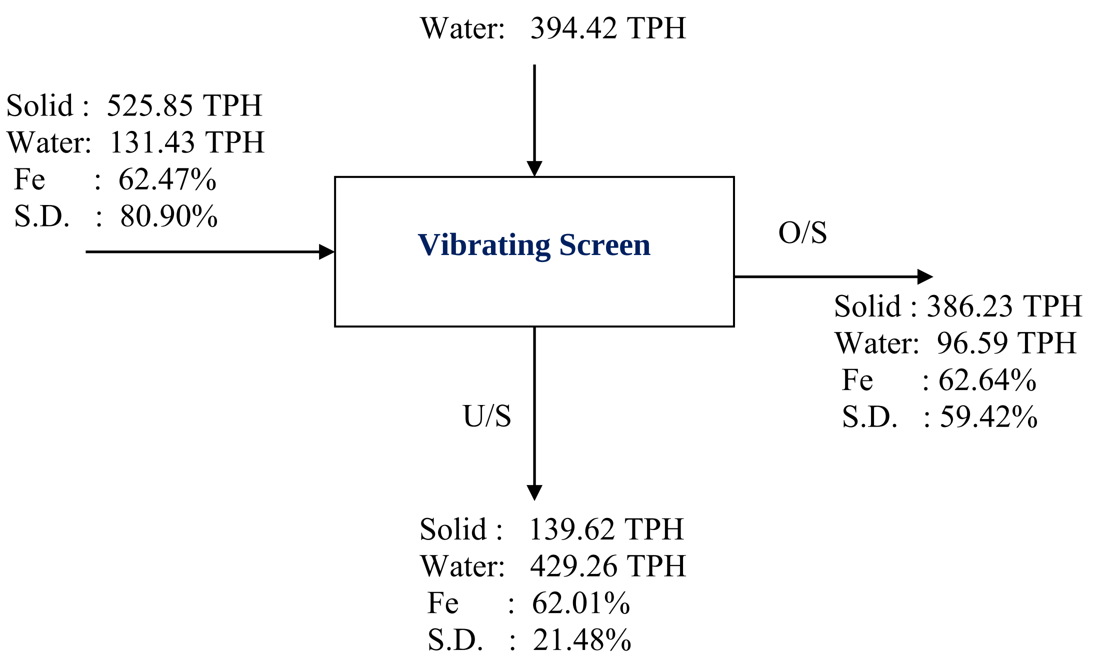
Solid : 52.46 TPH
Water: 78.65 TPH
Fe : 43.48%
S.D. : 8.07%

Tailings pond

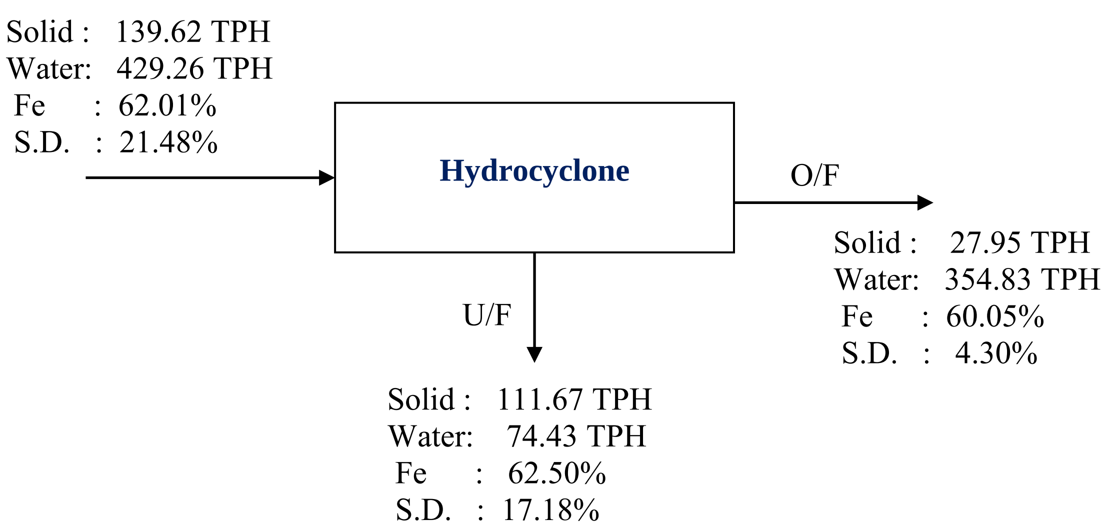
Recovered Water: 39.32 TPH

Solid : 52.46 TPH
Water: 39.33 TPH
Fe : 43.48%
S.D. : 8.07%

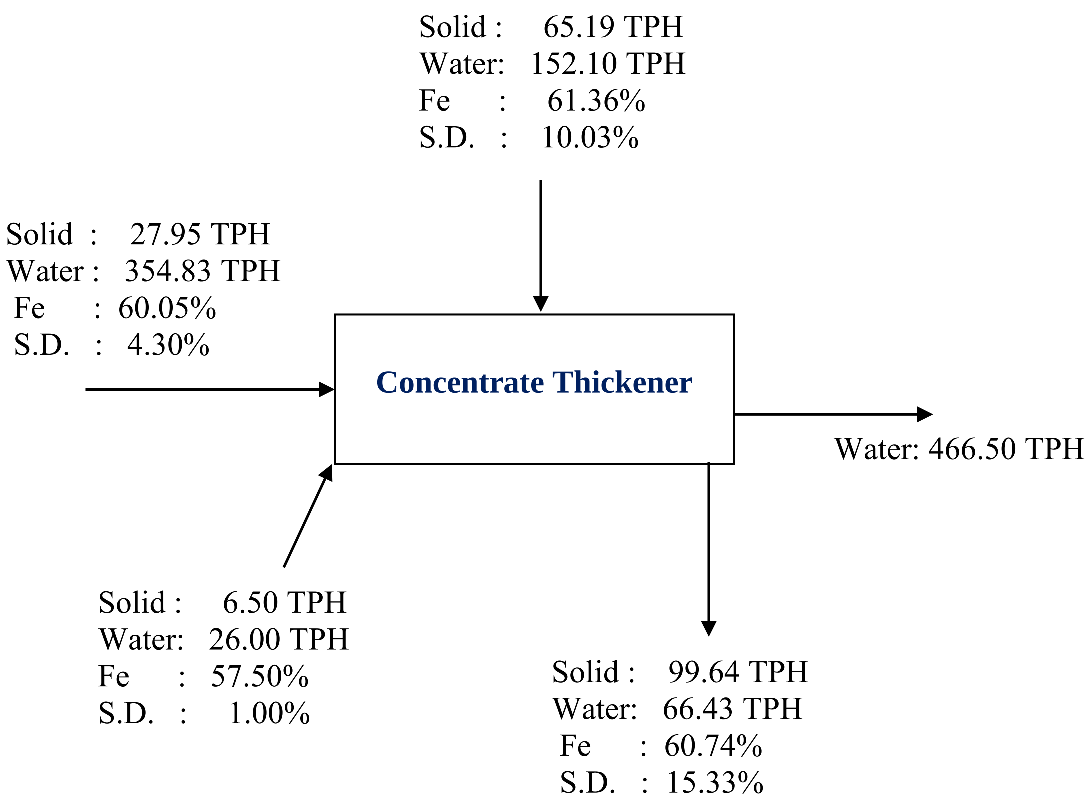
11. Vibrating Screen (1 mm size)



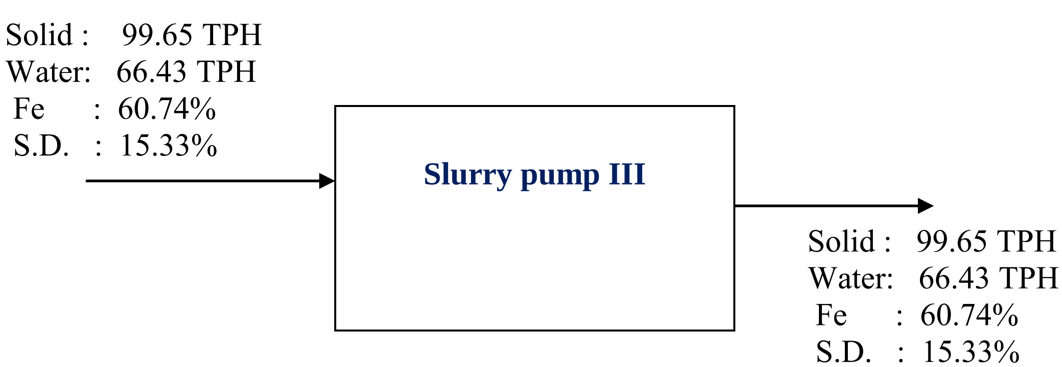
12. Hydrocyclone



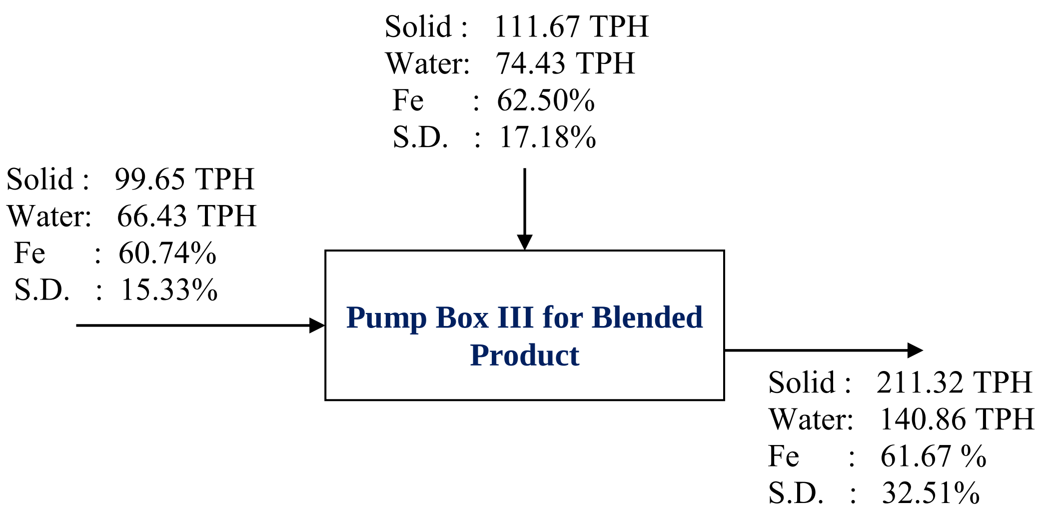
13. Concentrate Thickener



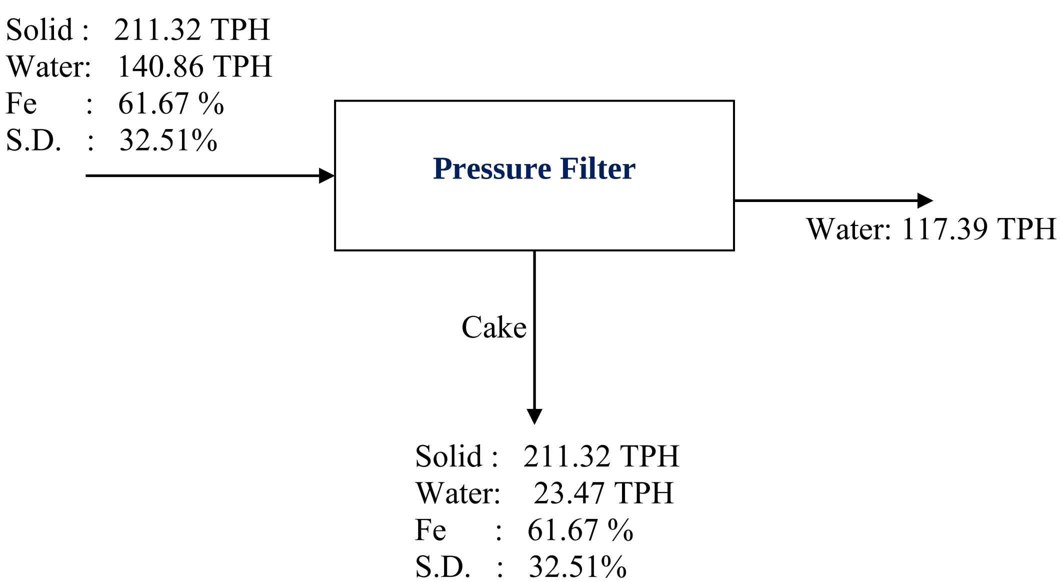
14. Slurry Pump III (Underflow of CT)



15. Pump Box III (Blended Product)



16. Pressure Filter



Water Balance

A. Water Handling

Sl. No.	List of Equipment	Water addition, TPH
1	Bulk Sample	45.50
2	Screw Scrubber	1469.00
3	Vibrating Screen	394.42
4	Rougher Magnetic Separator	496.47
5	Scavenger Magnetic Separator	192.27
Total		**2597.66**

B. Water Recovered

Sl. No.	List of Equipment	Water recovered, TPH
1	Intermediate Thickener	1196.84
2	Concentrate Thickener	466.50
3	Pressure Filter	117.39
4	Tailings Thickener	618.22
5	Tailing Pond	39.32
Total		**2438.27**

C. Water Contains in Products

Sl. No.	Name of the Product	Water contain, TPH
1	Pressure Filter	23.47
2	Vibrating screen	96.59
3	Tailing pond	39.33
Total		**159.39**

D. Make up water

Sl. No.	Name of the Product	Water contain, TPH
1	Water content in products	120.06
2	Water content in tailings	39.33
3	1% of handling loss	26.00
Total		**185.39**

Steel Limited

Regd. Office: JSW Centre
Bandra Kurla Complex,
Bandra (East), Mumbai – 400 051
CIN : L27102MH1994PLC152925
Phone : +91 22 4286 1000
Fax : +91 22 4286 3000
Website : www.jsw.in

No. JSW/S/O/2022/363

Date: 31/05/2021

To,
The Member Secretary
State Pollution Control Board, Odisha,
Paribesh Bhawan, A/118, Nilakantha Nagar, Unit-8,
BHUBANESWAR- 751012

Sub: - Submission of 9 Points NEERI Compliance Status Report of FY 2021-2022 for **Nuagaon Iron Ore Mine of M/s JSW Steel Ltd.**

Ref: - 2. New Consent Order No 2943 vide letter no 19513/IND-I-CON-2320 dated 06.12.2021.

Dear Sir,

With reference to aforesaid subject, please find enclosed herewith the 9 Points NEERI Compliance Status Report of FY 2021-22 for **Nuagaon Iron Ore Mine of M/s JSW Steel Ltd**.

Seeking your co-operation as always.

Thanking you,

Yours Faithfully
For JSW Steel Ltd

Baswaraj M Dalgade
(Authorized Signatory)

Encl: As above

Copy to- The Regional Officer, Regional Office, State Pollution Control Board, Keonjhar, At – Baniapat, College Road, Keonjhar-758 001, Office of the State Pollution Control Board, Odisha

NEERI REPORT COMPLIANCE STATUS -NUAGAON MINE

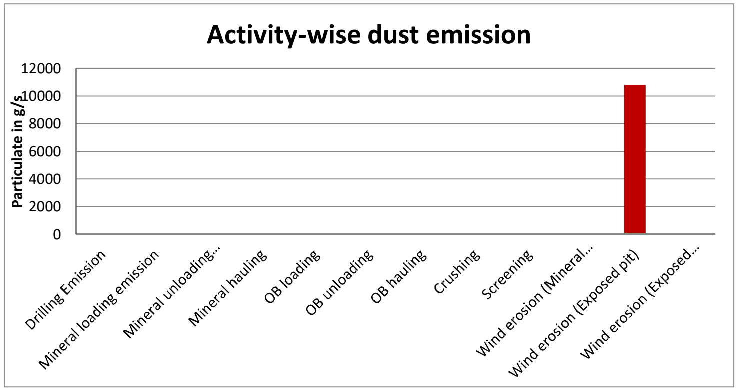
Sl. No.	Recommendation by CSIR-NEERI	Action Taken
1	The individual lease holders shall make assessment and quantification of emission load generation (in terms of air pollution, noise, wastewater and solid waste) from each of the mining activity (including transportation) for the period starting from 1st April to 31st March and submit report by June of every year. Efforts should be made to further eliminate/ minimize generation of air pollution/ dust, noise, wastewater, solid waste generation in successive years through use of better technology. Necessary guidance many be sought from Regional Officer, SPCB on load calculation.	The project has already been practicing different environmental safeguard measures for prevention of the air pollution. The measures are- 1. Mobile water sprinkling arrangement has been provided for the haul roads, processing area and loading / unloading points to minimize dispersion of air borne dust particles. 2. Fixed Sprinklers of 5.6 Km has been installed within mine lease area from Guali gate to Chenaguda. 3. Wet drilling arrangement with acoustic enclosure is in practice to control dust right at the source. 4. Dust Suppression System (Dry fog system) being provided at all appropriate places of mineral handling plants (crusher & screening plant) and other areas. Same are being maintained for proper dust control. Regular Monitoring of ambient air quality parameters being carried out through M/s BS Envi tech. Monitoring reports of FY 2021-22 were submitted in your good office vide our letter dated 31.05.2022. 5. No process water being discharged from the mine. Regular Monitoring of water quality parameters being carried out and Monitoring reports of FY 2021-22 were submitted in your good office vide our letter dated 31.05.2022. 6. Noise producing equipment's are covered as far as practicable. Workers engaged in Operations are provided with ear plugs / muffs. Besides this, acoustic enclosures are provided for all machines operating within the mines. Regular Noise Monitoring being carried out and Monitoring reports of FY 2021-22 were submitted in your good office vide our letter dated 31.05.2022. 7. The overburden generated as solid waste is stacked at the earmarked areas and will be stabilized after maturity. 8. The vehicles carrying the loaded materials are being covered with tarpaulin.

		9. Annual Assessment and quantification of emission load generation (in terms of air pollution, noise, waste water and solid waste) as per prescribed standards is enclosed as **Annexure 1.**
2	Monitoring of ambient air and fugitive emission in core zone shall be carried out on daily basis. Minimum four ambient air quality monitoring stations shall be installed in the core zone. Out of four, at least one on-line monitoring station shall be installed in case of mines having EC capacity of 3 MTPA of more. Moreover, one station should be located near the ore carrying truck entry and exit gate of mine. A letter in this regard has already been communicated to individual lease holder of capacity 3 MTPA and above vide Board's Letter no-7807, dt. 30.06.2018.	Regular monitoring of ambient air and fugitive emission is being carried out through M/s BS Envitech P Ltd. and Monitoring reports of FY 2021-22 were submitted in your good office vide our letter dated 31.05.2022. We have installed Three Continuous Ambient Air Quality Monitoring Stations (CAAQMS) and Digital Display Board in consultation with Regional Officer, Keonjhar. All 3 CAAQMS are equipped with data transfer facility to SPCB and we have authorized Phoenix Robotix Pvt. Ltd. (Datoms) for transmitting data to OSPCB and already completed the necessary setup for data transfer from all 3 locations to OSPCB Server. Data has been transferred from the Nuagaon Mine in the name of Ex-Lessee.
3	Monitoring in buffer zone shall be carried out by through NABET accredited agency preferably, at locations of nearest human habitation including schools and other public amenities located nearest to source of dust generation as applicable. The monitoring station shall be installed in core and buffer zone in consultation with Regional Officer, SPCB.	Regular Monitoring in buffer zone is being carried out at locations of nearest human habitation (residential area) engaging an NABET Accredited laboratory (B.S Envi Tech P. Ltd, Hyderabad). Monitoring reports of FY 2021-22 were submitted in your good office vide our letter dated 31.05.2022.
4	Monitoring stations shall be facilated for measurement of CO as an additional parameter to the other parameters SPM, PM_{10}, $PM_{2.5}$, SO_2 and NO_2. The monitoring result shall be compiled and submitted to Board on annual basis.	Regular Monitoring of CO as an additional parameter being carried out along with other AAQ data. Monitoring reports of FY 2021-22 were submitted in your good office vide our letter dated 31.05.2022.
5	All the vehicles engaged in mining and transporting activity in the mine shall have Pollution under Control (PUC) certificate. A record of the same shall be maintained for verification of inspecting agency.	Mineral carrying trucks are not allowed to go out of the lease area without tarpaulin cover and is being monitored by security personnel at the exit gate. Similarly, Security personnel are also do not allow the vehicles to enter into the mines without having valid PUC.

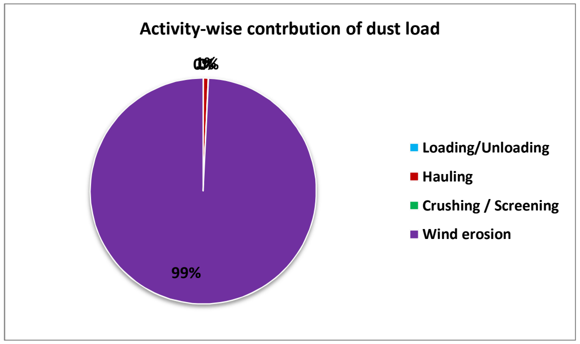
6	Noise level should be monitored near the major sources of noise generation within the core zone once in week and submit the report annually. Further, date, time and distance of measurement shall also be indicated with the noise levels in the report. The data shall be used to map the noise generation from different activities and efforts should be made to maintain the noise levels with the acceptable limits of CPCB. The monitoring schedule shall be informed to Regional Officer, SPCB in order to ensure his presence 25% of the monitoring programme.	Weekly Noise monitoring is being carried out through M/s BS Envitech P Ltd. (Accredited Laboratory). Monitoring reports of FY 2021-22 were submitted in your good office vide our letter dated 31.05.2022.
7	Measurement of flow rate of the springs and perennial nallah passing through the mining lease area shall be done on monthly basis. Identification of the perennial streams to be brought under the monitoring programme and the location the flow measurement shall be determined in consultation with Regional Officer, SPCB. The consolidated report shall be submitted to Board on annual basis.	No natural watercourse and water resources are obstructed due to mining operations & the same will be taken care of. Monitoring of flow rate measurement of the different water bodies is being carried out through M/s BS Envitech P Ltd. Monitoring reports of FY 2021-22 were submitted in your good office vide our letter dated 31.05.2022.
8	Effort shall be made to recycle or reuse the treated waste water from ETP of work shop and STP of residential colony instead of discharging to outside.	No colony provided in the working lease area. STP will be provided during colony construction. Oil & Grease trap system being maintained in the Workshop area.
9	Annual environmental sustainability report (ESR) shall be made highlighting the efforts made towards environmental protection with respect to different environmental components vis-à-vis production performance of the mine on monthly basis. The data collected as per EC and CTE/CTO conditions should be utilized to prepare the annual sustainability report. The report shall be submitted to SPCB and RO, MoEF&CC by June of every year.	Nuagaon Mine started operations since July 2020. Annual environmental sustainability report (ESR) is enclosed as **Annexure 2.**

RESULTS OF DUST LOAD CALCULATIONS

	Particulate matter in (g/s)	Particulate matter in (kg/d)	Particulate matter (kg per ton of ore)
Drilling Emission	0.0438556	3.789123634	0.000168405
Mineral loading emission	0.05335409	4.609793663	0.00020488
Mineral unloading emission	0.38742936	33.47389654	0.001487729
Mineral hauling	31.3447859	2708.189503	0.120363978
OB loading	0.55395989	47.86213415	0.002127206
OB unloading	0.42535041	36.7502757	0.001633346
OB hauling	42.6937518	3688.740153	0.163944007
Crushing	2.22222222	192	0.008533333
Screening	2.08333333	180	0.008
Wind erosion (Mineral stack)	1.2782442	110.4402988	0.004908458
Wind erosion (Exposed pit)	10798.4518	932986.2339	41.46605484
Wind erosion (Exposed OB dump)	14.1353336	1221.292826	0.054279681
Total	**10893.67**	**941213.38**	**41.831706**



Major Activity	Dust load (kg/day)
Loading/Unloading	122.6961
Hauling	6396.92966
Crushing / Screening	372
Wind erosion	934317.967



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Annual Environmental Sustainability Report (ESR) for Nuagaon Iron Ore Mine of M/s JSW Steel Ltd.

Introduction-

The Nuagaon Iron Ore Mine (erstwhile lessee M/s KJS Ahluwalia) was one of the mines whose lease expired on 31.03.2020. The lease area is located in villages Nuagaon, Barapada, Gandhalpada, Guali, Katesahi, Parediposi, KohlaRudukela, Panduliposhi and Topadihi villages under Barbil Tehsil of Keonjhar District, Odisha State.

In pursuant to the Mines and Minerals (Development and Regulation) Act, 1957 and the Mineral (Auction) Rules, 2015, Govt. of Odisha issued the notice inviting tender dated December 6, 2019 for commencement of the auction process to grant the mining lease in respect of Nuagaon Iron Ore Block over an area of 776.969 ha as per DGPS (767.284 ha as per ROR) in villages Nuagaon, Barapada, Gandhalpada, Guali, Katesahi, Parediposi, KohlaRudukela, Panduliposhi and Topadihi under Barbil Tehsil of Keonjhar District, Odisha for a resource size of about 789.04 Million tonnes (Mt). The e-auction process was conducted in accordance with the tender document and the mineral auction rule, 2015 for the said mineral block and M/s JSW Steel Limited was declared as the preferred bidder under Rule 9(9)(iii) of Mineral (Auction) Rules 2015.

Without prejudice to the generality of the provisions of section 8B(2) of the MMDR Act, 1957, the details of the valid rights, approvals, clearances, licenses and the like held by the previous lessee are vested in favor of M/S JSW Steel Ltd by the Govt. of Odisha for a period of 2 years from the date of execution of lease deed or till the date of getting fresh approvals, clearances, licenses, permits, and the like, whichever is earlier vide vesting order No-4167/SM, dated **29.05.2020**. M/s JSW Steel Limited being successful bidder upon execution of mining lease deed, the successful bidder shall immediately, but not later than one hundred twenty days from the date of execution of mining lease, apply afresh for all necessary rights, approvals, clearances, licenses and the like under the applicable statutes, rules or regulations, as the case may be, for obtaining the necessary clearances to enable further continuance of the mining operations beyond two years and vesting order shall be valid for a period of two years from the date of execution of new lease deed or till the date of getting all fresh approvals, clearances, licenses, permits, and the like, whichever is earlier.

The mining lease was granted in favor of M/s JSW Steel Limited for a period of 50 years w.e.f 27.06.2020. Subsequent to signing of the MDPA with the Collector, Keonjhar**, M/s JSW Steel Limited** has made payment of the third instalment being the eighty percent of the upfront value and executed and registered the mining lease with the Government of Odisha on 27.06.2020.

Indicative Coordinates Range of the Nuagaon Iron Ore Mine

Latitudes	:	21^0 57’ 12.91896” N to 21^0 59’ 34.26648” N
Longitudes	:	85^0 16’ 06.04164” E to 85^0 19’ 24.93228” E

Fully mechanized open cast method of mining by drilling and blasting and by deploying HEMM equipment’s like hydraulic drills and excavators, wheel loaders, dumpers, will be undertaken. The height and width of the benches for iron ore will be kept at 9 m and 15 m respectively. The working of benches will be commenced from top and extended to bottom benches. The excavated ROM ore is proposed to be processed in the crushing and screening plants to obtain the lump and fine ore as product mix. The iron ore lumps and iron ore fines extracted from the mine will be transported through railway/port/road to JSW Steel Plants.

Production in FY 2021-22

Nuagaon mining operations started from 01.07.2020 based on the vested approvals. From April 2021 to March 2022, Nuagaon Mine has produced 6264155.00 Mt Iron Ore (ROM) and dispatched to steel plants.

Environment Management in Nuagaon Mine

Air Management-

Blasting Operation

- Controlled blasting method is in practice by restriction of explosive charge in the holes.
- Well-designed blast by effective stemming and use of mili second delay detonators, Proper blasting designing to see that the optimum breakage occurs.
- To control ground vibrations and arrest fly rocks, advanced initiation system is being used for blasting
- Ground vibrations are also being monitored and the results are well within limits.

Excavation, Hauling and Crushing & Screening

- Dry fog system for crusher & screen plants are provided.
- Proper maintenance of HEMM
- Using sharp teeth for shovels and other soil excavation equipment, and their periodical replacements.
- Acoustic enclosures for operator cabin.
- Avoiding overloading of dumpers
- Provision of dust filters / masks to workers working at highly dust prone and affected areas
- Imparting sufficient training to operators on safety and Environmental parameters.

Transportation

- Regular water sprinkling is being carried out by engaging mobile water tankers on the mine benches, mine haul, loading and unloading points and transfer points for dust suppressions.
- Maintenance of haul road by regular grading is carried out through grader, dozer.
- Ensuring that all mineral trucks are covered by tarpaulin.
- Vehicular emissions controlled through regular and proper preventive maintenance schedules.
- It is ensured that there is no overloading of trucks by having Quick Dispatch system at the weigh bridge near the dispatch gate.
- Regular water sprinkling arrangements have been made on the transportation roads/public road through mobile water tankers.

Wet Drilling And Dust Extractor System In Drilling Operation

Quick Dispatch System

Water Tanker Arrangement For Haul Road Dust Suppression

Dry Fog System in Mineral Handling Plants

Consolidated Air Quality Monitoring Data of FY 2021-2022

NUAGAON IRON ORE MINES										
AAQ DATA FOR THE PERIOD APRIL 2021 TO MARCH 2022 (Microgram/ Cubic. Meter)										
	PM10 [µg/m3]		**PM2.5 [µg/m3]**		**SO2 [µg/m3]**		**NO2 [µg/m3]**		**CO [mg/m3]**	
	Maximum	**Minimum**	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**	**Minimum**
CORE ZONE										
Mines Office	**77**	**33**	**29**	**11**	**13**	**7.9**	**14.4**	**9.3**	**0.73**	**0.25**
Near Dispensery	**69**	**34**	**25**	**11**	**12.5**	**7.7**	**13.8**	**9.2**	**0.74**	**0.27**
Near Katesahi Exit Gate area	**77**	**35**	**29**	**12**	**12.9**	**9.1**	**14.2**	**10.7**	**0.81**	**0.31**
Near LP 99	**73**	**31**	**28**	**11**	**12.3**	**7.8**	**13.6**	**9.3**	**0.73**	**0.35**
Entry & Exit Gate	**93**	**41**	**35**	**13**	**13.1**	**9.3**	**14.7**	**10.6**	**0.86**	**0.39**
Near Bneficition Plant	**83**	**50**	**32**	**17**	**12.3**	**8.9**	**13.8**	**10.6**	**0.73**	**0.35**

Near Monet QDS	**90**	**60**	**34**	**21**	**13**	**10.5**	**14.5**	**11.8**	**0.73**	**0.49**
Near Katesahi QDS	**94**	**40**	**34**	**14**	**13.3**	**9.4**	**14.7**	**10.7**	**0.82**	**0.43**
Near Boundary Pillar 99	**94**	**36**	**37**	**12**	**13.3**	**8.7**	**14.9**	**10.1**	**0.91**	**0.35**
BUFFER ZONE										
Barpada Village	**71**	**35**	**26**	**11**	**11.7**	**7.7**	**13**	**9.2**	**0.62**	**0.29**
Katesahi Village	**66**	**31**	**24**	**11**	**10.4**	**7.1**	**11.9**	**8.4**	**0.52**	**0.22**
Rengelapbeda Village	**74**	**39**	**27**	**12**	**12.1**	**9.2**	**13.7**	**10.6**	**0.71**	**0.39**
Panduluposi Village	**70**	**35**	**26**	**12**	**12.2**	**7.9**	**13.7**	**9.2**	**0.72**	**0.37**
NAAQ standards for Industrial, residential, Rural and Other Areas (24 hourly standard)	**100 [µg/m3]**		**60 [µg/m3]**		**80 [µg/m3]**		**80 [µg/m3]**		**2 [mg/m3] (8 hourly)**	

Water & OB Dump Management

- Garland drains maintained of suitable size around mine area and dump with proper gradients to prevent rain water descent into active mine area.
- Settling ponds maintained to prevent flow of fine particles from OB / Waste dumps, check dams, parapet / retaining walls & garland drains.
- Usage of stored water in the settling ponds for watering of haul roads, vehicle washing and green belt development etc.
- De- silting of garland drains & settling ponds are being carried out at regular intervals.
- Maintenance of all the runoff management structures.

Retaining Wall At Katasahi

Check Dam Provided At Topadihi Nalla

Nalla Side Plantation

Dump Plantation

Consolidated Ground Water Quality Monitoring Data of FY 2021-2022

NUAGAON IRON ORE MINES					
katsai Village					
Parameter	**Units**	**max**	**min**	**Acceptable Limits**	**Permissible Limits**
PH	**-**	**6.75**	**6.69**	**6.5-8.5**	**No Relaxation**
Total Hardness	**mg/l**	**80**	**49**	**200**	**600**
Iron	**mg/l**	**0.1**	**0.07**	**1**	**No Relaxation**
Chlorides	**mg/l**	**59**	**48**	**250**	**1000**
Total Dissolved Solids	**mg/l**	**236**	**206**	**500**	**2000**
Sulphates	**mg/l**	**27**	**22**	**200**	**400**
Fluoride	**mg/l**	**0.42**	**0.31**	**1**	**1.5**
Rengelabeda Village					
Parameter	**Units**	**max**	**min**	**Acceptable Limits**	**Permissible Limits**
PH	**-**	**6.84**	**6.75**	**6.5-8.5**	**No Relaxation**

Total Hardness	**mg/l**	**90**	**80**	**200**	**600**
Iron	**mg/l**	**0.09**	**0.08**	**1**	**No Relaxation**
Chlorides	**mg/l**	**69**	**66**	**250**	**1000**
Total Dissolved Solids	**mg/l**	**275**	**262**	**500**	**2000**
Sulphates	**mg/l**	**31**	**29**	**200**	**400**
Fluoride	**mg/l**	**0.46**	**0.45**	**1**	**1.5**
Barpada Village					
Parameter	**Units**	**max**	**min**	**Acceptable Limits**	**Permissible Limits**
PH	**-**	**6.82**	**6.81**	**6.5-8.5**	**No Relaxation**
Total Hardness	**mg/l**	**80**	**72**	**200**	**600**
Iron	**mg/l**	**0.11**	**0.1**	**1**	**No Relaxation**
Chlorides	**mg/l**	**76**	**70**	**250**	**1000**
Total Dissolved Solids	**mg/l**	**268**	**265**	**500**	**2000**
Sulphates	**mg/l**	**35**	**32**	**200**	**400**
Fluoride	**mg/l**	**0.47**	**0.45**	**1**	**1.5**
Malda Village					
Parameter	**Units**	**max**	**min**	**Acceptable Limits**	**Permissible Limits**
PH	**-**	**6.82**	**6.79**	**6.5-8.5**	**No Relaxation**
Total Hardness	**mg/l**	**70**	**58**	**200**	**600**
Iron	**mg/l**	**0.09**	**0.07**	**1**	**No Relaxation**
Chlorides	**mg/l**	**60**	**56**	**250**	**1000**
Total Dissolved Solids	**mg/l**	**224**	**220**	**500**	**2000**

Sulphates	**mg/l**	**27**	**26**	**200**	**400**
Fluoride	**mg/l**	**0.41**	**0.40**	**1**	**1.5**
Guali Village					
Parameter	**Units**	**max**	**min**	**Acceptable Limits**	**Permissible Limits**
PH	**-**	**6.75**	**6.72**	**6.5-8.5**	**No Relaxation**
Total Hardness	**mg/l**	**66**	**65**	**200**	**600**
Iron	**mg/l**	**0.13**	**0.09**	**1**	**No Relaxation**
Chlorides	**mg/l**	**72**	**70**	**250**	**1000**
Total Dissolved Solids	**mg/l**	**268**	**265**	**500**	**2000**
Sulphates	**mg/l**	**29**	**28**	**200**	**400**
Fluoride	**mg/l**	**0.45**	**0.44**	**1**	**1.5**
D Top Water					
Parameter	**Units**	**max**	**min**	**Acceptable Limits**	**Permissible Limits**
PH	**-**	**6.83**	**6.81**	**6.5-8.5**	**No Relaxation**
Total Hardness	**mg/l**	**85**	**84**	**200**	**600**
Iron	**mg/l**	**0.11**	**0.1**	**1**	**No Relaxation**
Chlorides	**mg/l**	**78**	**76**	**250**	**1000**
Total Dissolved Solids	**mg/l**	**306**	**302**	**500**	**2000**
Sulphates	**mg/l**	**0.46**	**35**	**200**	**400**
Fluoride	**mg/l**	**0.48**	**0.46**	**1**	**1.5**
Panduliposshi Village					
Parameter	**Units**	**max**	**min**	**Acceptable Limits**	**Permissible Limits**

PH	**-**	**6.91**	**6.73**	**6.5-8.5**	**No Relaxation**
Total Hardness	**mg/l**	**100**	**86**	**200**	**600**
Iron	**mg/l**	**0.13**	**0.11**	**1**	**No Relaxation**
Chlorides	**mg/l**	**74**	**70**	**250**	**1000**
Total Dissolved Solids	**mg/l**	**285**	**272**	**500**	**2000**
Sulphates	**mg/l**	**32**	**30**	**200**	**400**
Fluoride	**mg/l**	**0.45**	**0.43**	**1**	**1.5**
Nuagaon Village					
Parameter	**Units**	**max**	**min**	**Acceptable Limits**	**Permissible Limits**
PH	**-**	**6.72**	**6.69**	**6.5-8.5**	**No Relaxation**
Total Hardness	**mg/l**	**95**	**94**	**200**	**600**
Iron	**mg/l**	**0.1**	**0.08**	**1**	**No Relaxation**
Chlorides	**mg/l**	**82**	**79**	**250**	**1000**
Total Dissolved Solids	**mg/l**	**330**	**320**	**500**	**2000**
Sulphates	**mg/l**	**36**	**34**	**200**	**400**
Fluoride	**mg/l**	**0.48**	**0.46**	**1**	**1.5**

Consolidated Surface Water Quality Monitoring Data of FY 2021-2022

SUNA RIVER			
Parameter	max	min	**Limits for Stream Water Standards**
PH	6.82	6.64	**6.5-8.5**

Total Dissolved Solids	106	80	**1500**
Chlorides	8.5	6	**600**
Iron	0.15	0.1	**50**
Fluorides	0.13	0.1	**1.5**
BOD	3	2	**3**
DO	5.2	4.9	**4**
Suna River Upstream			
PH	6.74	6.56	**6.5-8.5**
Total Dissolved Solids	134	92	**1500**
Chlorides	12	7.1	**600**
Iron	0.15	0.12	**50**
Fluorides	0.14	0.1	**1.5**
BOD	9	3	**3**
DO	5.3	4.8	**4**
Suna River Downstream			
PH	6.92	6.72	**6.5-8.5**
Total Dissolved Solids	174	92	**1500**
Chlorides	18	7	**600**
Iron	0.23	0.13	**50**
Fluorides	0.26	0.15	**1.5**
BOD	9	8	**3**
DO	6.3	4.6	**4**
Karo River Upstream			
PH	6.77	6.61	**6.5-8.5**
Total Dissolved Solids	168	106	**1500**
Chlorides	15	8.5	**600**

Iron	0.2	0.11	**50**
Fluorides	0.17	0.1	**1.5**
BOD	5	2	**3**
DO	5.8	5	**4**
Karo River Down stream			
PH	6.94	6.69	**6.5-8.5**
Total Dissolved Solids	180	120	**1500**
Chlorides	25	13	**600**
Iron	0.23	0.12	**50**
Fluorides	0.23	0.14	**1.5**
BOD	8	3	**3**
DO	5.3	5	**4**
Kakarpani Nala			
PH	6.89	6.64	**6.5-8.5**
Total Dissolved Solids	126	94	**1500**
Chlorides	7.5	5	**600**
Iron	0.1	0.04	**50**
Fluorides	0.13	0.1	**1.5**
BOD	3	2	**3**
DO	6.5	5.6	**4**
Kakarpani Nala Upstream			
PH	6.74	6.71	**6.5-8.5**
Total Dissolved Solids	162	120	**1500**
Chlorides	9.1	7	**600**
Iron	0.1	0.06	**50**
Fluorides	0.2	0.13	**1.5**

BOD	6	3	**3**
DO	5.6	5.1	**4**
Kakarpani Nala Downstream			
PH	6.78	6.68	**6.5-8.5**
Total Dissolved Solids	174	152	**1500**
Chlorides	12	7.6	**600**
Iron	0.15	0.07	**50**
Fluorides	0.25	0.14	**1.5**
BOD	7	4	**3**
DO	6.2	5.5	**4**
Theherei Nala			
PH	6.87	6.64	**6.5-8.5**
Total Dissolved Solids	140	75	**1500**
Chlorides	8.5	7.1	**600**
Iron	0.3	0.07	**50**
Fluorides	0.15	0.11	**1.5**
BOD	6	2	**3**
DO	6	5	**4**
Topadihi Nala Upstream			
PH	6.96	6.58	**6.5-8.5**
Total Dissolved Solids	178	116	**1500**
Chlorides	30	6.3	**600**
Iron	0.2	0.07	**50**
Fluorides	0.2	0.1	**1.5**
BOD	5	1	**3**
DO	5.8	5.1	**4**

Topadihi Nala Down stream			
PH	7.02	6.7	**6.5-8.5**
Total Dissolved Solids	194	110	**1500**
Chlorides	45	7	**600**
Iron	0.25	0.12	**50**
Fluorides	0.25	0.13	**1.5**
BOD	9	2	**3**
DO	6.3	4.5	**4**

Noise Management

- Providing sound proof operator's cabin for equipment like dumpers, shovel, tippers, etc.
- Planting trees at various places within the lease area to act as acoustic barriers.
- Proper and regular maintenance of vehicles, machinery and other equipment. All HEMMs are monitored for any abnormal sound and rectified with due precaution by maintenance personnel.
- Providing workers with ear muffs & earplugs against high noise levels.
- Conducting regular health check-ups of workers including Audiometry test
- Controlling the time of exposure of workers towards high noise areas.

Consolidated Noise Quality Monitoring Data of FY 2021-2022

Nuagaon Iron Ore Mines			
	max	**min**	**STANDARDS**
CORE ZONE			
Ore crushing plant	82.7	78.2	**85 dB(A)**
Mobile screen plant	80.3	75.7	
Workshop Area	81.5	72.7	
Mines Face/Bench	81	72.6	
Haulage Road	80.5	73.5	
Ore storage & loading point	80.5	77.2	
Waste Dump	77.3	65	
Magazine Area	70.7	54.8	

Drilling machine	84.2	80.5	
Excavator	81.7	77.4	
Dozer	82	76.8	
Dumper	80.6	76.3	
Loader	82.8	79	
DG Set	79.6	68.3	
Mines Office	60.5	50.5	

BUFFER ZONE						
					STANDARDS	
	max (Leq Day)	**min (Leq Day)**	**max (Leq Night)**	**min (Leq Night)**	**Day Equivalent**	**Night Equivalent**
BARPADA VILLAGE	**53.1**	**50.6**	**43.4**	**38.8**	**55 dB(A)**	**45 dB(A)**
KATE SAHI VILLAGE	**51.5**	**48.7**	**40.6**	**36.9**		
REBELABEDA VILLAGE	**53.3**	**52.3**	**43.8**	**41.1**		
PANDULIPOSHI VILLAGE	**53.4**	**51.7**	**42.6**	**39.5**		
EAST BOUNDARY	**66.5**	**61.5**	**57.2**	**54.6**		
WEST BOUNDARY	**69.1**	**63.5**	**58.8**	**55.8**		
NORTH BOUNDARY	**66.2**	**61.6**	**57.5**	**55.8**		
SOUTH BOUNDARY	**68.6**	**61.1**	**58.4**	**53.8**		

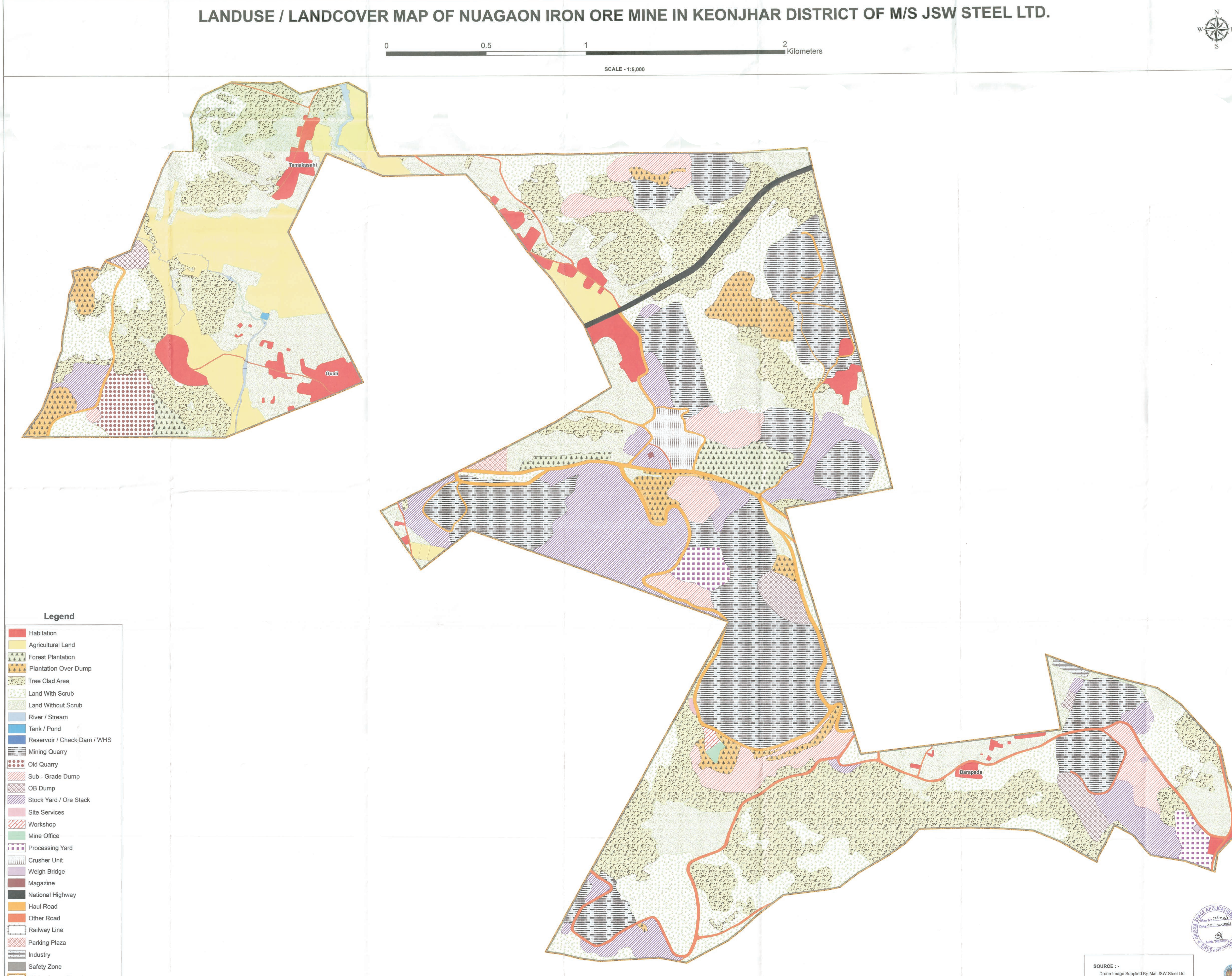
Electronic Digital Display Board at Nuagaon Mine Gate

<u>Nuagaon Environmental Protection Measures Expenditure (head wise breakup) incurred from in FY July 2020-YTD</u>

Particulars	Approximately Cost incurred (in Crores)
Dust Suppression (Wet Drilling, Dry Fog System, Mobile Haul road water sprinkling system, etc.)	0.20
Fixed Water Sprinkling Project	0.10
Online Environmental Monitoring System (CAAQMS & Digital	1.50

Display Board)	
Manual Environment Monitoring	0.15
ETP/Mechanized Oil Grease Trap System	0.10
Water Sprinkling on National Highway/nearby village/transportation roads	0.30
OB Dump & Surface Run-off Management	0.10
Environment Awareness in MEMC Week 2020-21	0.05
Grand Total (Rs. in Cr.)	**2.50**

LANDUSE / LANDCOVER MAP OF NUAGAON IRON ORE MINE IN KEONJHAR DISTRICT OF M/S JSW STEEL LTD.



SOURCE : -

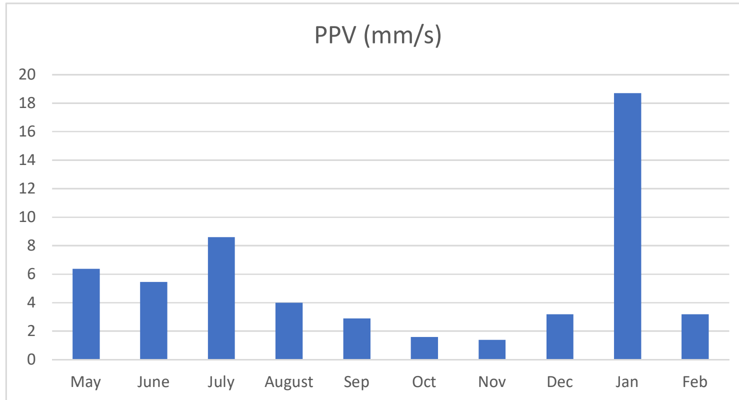
Drone Image Supplied By M/s JSW Steel Ltd.
Month - August , Year - 2021


realme
Shot on realme 8 5G
2023 03 25 11:13

NUAGAON IRON ORE MINES

Graphical variation of ppv

Month	PPV (mm/s)
May	6.37
June	5.45
July	8.6
August	4
Sep	2.9
Oct	1.61
Nov	1.4
Dec	3.19
Jan	18.7
Feb	3.19

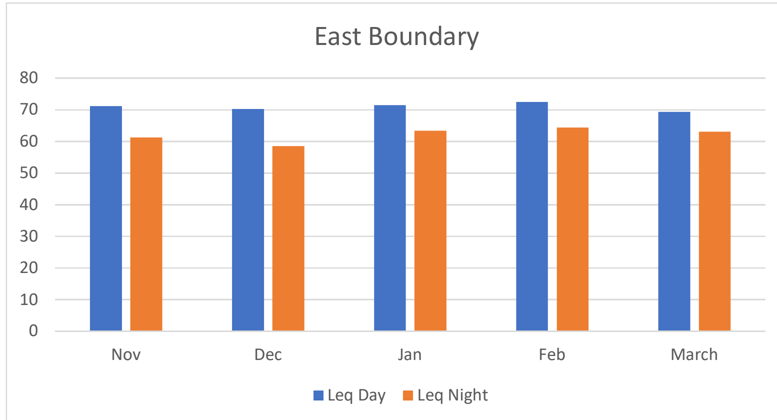


NUAGAON IRON ORE MINES

Ambient Noise Data db(A)

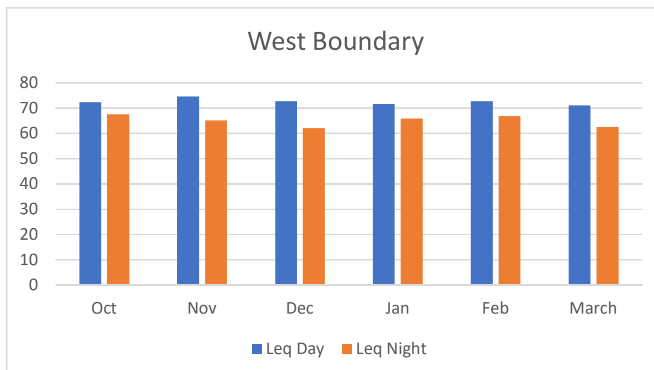
1. East Boundary

Month	Leq Day	Leq Night
Nov	71.2	61.3
Dec	70.3	58.5
Jan	71.5	63.4
Feb	72.5	64.4
March	69.4	63.1



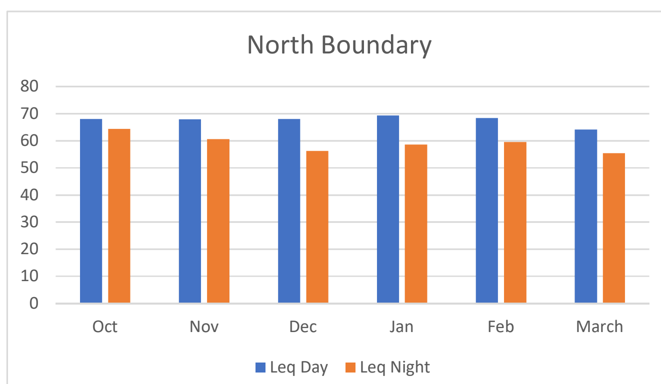
West Boundary

Month	Leq Day	Leq Night
Oct	72.4	67.6
Nov	74.6	65.2
Dec	72.8	62.1
Jan	71.7	65.9
Feb	72.7	66.9
March	71.1	62.6



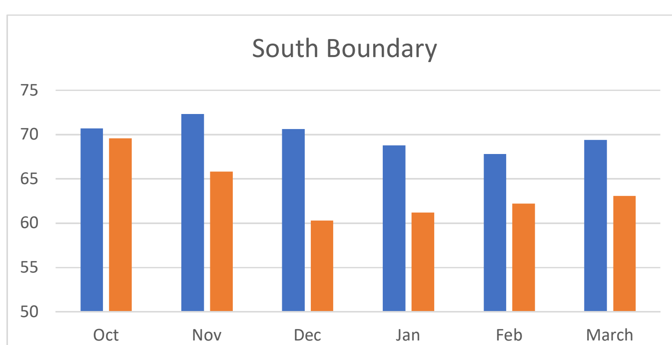
North Boundary

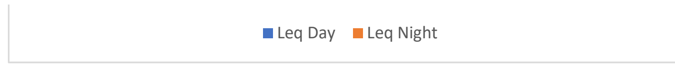
Month	Leq Day	Leq Night
Oct	68.1	64.4
Nov	67.9	60.6
Dec	68.1	56.3
Jan	69.4	58.6
Feb	68.4	59.6
March	64.2	55.4



South Boundary

Month	Leq Day	Leq Night
Oct	70.7	69.6
Nov	72.3	65.8
Dec	70.6	60.3
Jan	68.8	61.2
Feb	67.8	62.2
March	69.4	63.1




Leq Day
Leq Night


2022.10.26 10:32

Tel : 2564033/2563924
EPABX : 2561909/2562847
E-mail: hwmd@ ospcboard.org /
paribesh1@ ospcboard.org
Website: www.ospcboard.org

STATE POLLUTION CONTROL BOARD, ODISHA

[DEPARTMENT OF FOREST & ENVIRONMENT, GOVERNMENT OF ODISHA]
Paribesh Bhawan, A/118, Nilakantha Nagar, Unit – VIII
Bhubaneswar – 751012, INDIA

BY SPEED POST

FORM 2
[See rule 6(2)]

RENEWAL OF AUTHORISATION BY STATE POLLUTION CONTROL BOARD, ODISHA TO THE OCCUPIER UNDER HAZARDOUS AND OTHER WASTES (MANAGEMENT AND TRANSBOUNDARY MOVEMENT) RULES, 2016

1. Number of authorization: **IND-IV-HW-1348/** 5322 and date of issue: 31-03-2022
2. Reference of application (No. and date): **3869777, dtd. 24-12-2021/ 08-02-2022.**
3. **Nuagaon Iron Ore Mine of M/s JSW Steel Ltd.** is hereby granted an authorization based on the enclosed signed inspection report for generation, storage, transport, reuse, utilization, disposal or any other use of hazardous or other wastes or both in the premises situated **At - Nuagaon, PO : Guali, Barbil, Dist- Keonjhar, Odisha.**

Details of Authorization

Sl. No	Category of Hazardous Waste as per the Schedules I, II and III of these Rules	Waste Description	Quantity	Authorized Mode of Disposal or Recycling or utilization or Co-processing, etc.
1.	Schedule - I Stream - 5.1	Used / Spent Oil	150 T/A	Storage in containers over impervious floor under well ventilated covered shed followed by disposal through Actual Users having valid authorization from SPCB, Odisha
2.	Schedule - I (Stream – 3.3, 5.2 & 33.2)	Wastes / Residue Containing Oil	100 T/A	Storage in impervious pits / containers under well ventilated covered shed followed by disposal through Actual Users / Authorized HW incinerator / Co-processing in Cement Kiln authorized by SPCB, Odisha / Common Hazardous Waste Treatment Storage Disposal Facility (CHWTSDF)

Sl. No	Category of Hazardous Waste as per the Schedules I, II and III of these Rules	Waste Description	Quantity	Authorized Mode of Disposal or Recycling or utilization or Co-processing, etc.
3.	Schedule - I Stream – 33.1	Discarded containers / barrels / liners contaminated with hazardous wastes/ chemicals	100 T/A	Storage on impervious floor under well ventilated covered shed followed by captive reuse / disposal through original supplier /Actual Users authorized by SPCB, Odisha

(1) The authorization shall be valid up to **31-03-2023**.

(2) The authorization is subject to the following general and specific conditions.

A. General Conditions of authorisation:

1. The authorized person shall comply with the provisions of the Environment (Protection) Act, 1986, and the rules made there under.

2. The authorization or its renewal shall be produced for inspection at the request of an officer authorized by the State Pollution Control Board.

3. The person authorized shall not rent, lend, sell, transfer or otherwise transport the hazardous and other wastes except what is permitted through this authorisation.

4. Any unauthorized change in personnel, equipment or working conditions as mentioned in the application by the person authorized shall constitute a breach of his authorisation.

5. The person authorized shall implement Emergency Response Procedure (ERP) for which this authorisation is being granted considering all site specific possible scenarios such as spillages, leakages, fire, etc. and their possible impacts and also carry out mock drill in this regard at regular interval of time.

6. The person authorized shall comply with the provisions outlined in the Central Pollution Control Board guidelines on "Implementing Liabilities for Environmental Damages due to Handling and Disposal of Hazardous Waste and Penalty". Any accident in this respect shall be intimated to the Board immediately.

7. It is the duty of the authorized person to take prior permission of the State Pollution Control Board to close down the facility.

8. The hazardous and other waste which gets generated during recycling or reuse or recovery or pre-processing or utilization of imported hazardous or other wastes shall be treated and disposed of as per specific conditions of authorisation.

9. An application for the renewal of an authorisation shall be made as laid down under these Rules.

10. Any other conditions for compliance as per the Guidelines issued by the Ministry of Environment, Forest and Climate Change or Central Pollution Control Board from time to time.

11. Annual return shall be filed by 30th day of June of every year for the preceding period from April to March.

B. Specific Conditions :

1. Authorization granted herewith does not relieve you in complying with other provision laid down under Water (PCP) Act, 1974, Air (PCP) Act, 1981 and Environment (Protection) Act, 1986, and the Rules made there under.

2. This authorization is subject to statutory and other clearances from Govt. of Odisha and / or Govt. of India as and when applicable.

3. In case the quantity of generation of hazardous Waste exceeds the Authorized quantity, the industry / mine shall apply for amendment of Authorization order.

4. The industry / mine shall strictly comply to the provisions of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and amendments made thereafter.

5. Annual returns in Form - 4 (See Rules- 6 (5), 13 (8), 16 (6) & 20 (2)) shall be submitted to the Board for the financial year by 30th June of every year. It shall contain the detail quantities of generation, storage and disposal of different type of hazardous wastes such as recyclable, incinerable, land disposable.

6. Steps shall be taken for reduction and prevention of the hazardous waste generated or for recycling or reuse.

7. Environmental Information with respect to Air, Water, Hazardous Waste and Hazardous Chemicals shall be displayed at the main gate for public view.

8. The transport of the hazardous and other waste shall be in accordance with the provisions of the Rule, 2016 and the rules made by the Central Government under the Motor Vehicles Act, 1988 and the guidelines issued by the Central Pollution Control Board from time to time in this regard.

9. The occupier shall provide the transporter with the relevant information in **Form 9**, regarding the hazardous nature of the wastes and measures to be taken in case of an emergency and shall label the hazardous and other wastes containers as per **Form 8**.

10. In case of transportation of hazardous waste and other wastes for recycling or utilization including co-processing to outside the state, the sender shall intimate both the State Pollution Control Boards before handing over the waste to the transporter.

11. Manifest system (Movement document) shall be strictly followed as per Rule-19 and to be submitted to this office as per the Rule. The industry / mine shall check the authenticity of the way bill of the transport vehicle to ensure supply of hazardous waste to the authorized destination.

12. The hazardous waste shall be sold if required only to Actual User having valid authorization from the State Pollution Control Board, Odisha and concerned SPC Board. Details of such wastes shall be entered in the passbook issued by respective SPCB.

13. All the hazardous waste shall be stored in impervious pits / containers / floors under cover shed with adequate capacity having spill containment facility. The spilled hazardous waste shall be re-collected and stored in impervious pits / containers / floors under cover shed prior to sale / disposal.

14. The schedule of hazardous waste and the quantity as specified shall only be disposed off as per the stipulation prescribed in this authorisation.

15. This authorization does not permit you to either receive and process or generate hazardous waste in case validity of Consent to Operate of your industry / mine ceases. However you can carry out handling, storage, treatment, transport and disposal of hazardous waste and other wastes generated previously during such period to avoid accumulation of hazardous waste.

16. The industry / mine shall store the accumulated hazardous waste for a period not exceeding 90 days and shall dispose as per the stipulation prescribed in this authorisation order. In case, generation of any category of Hazardous Waste is less than 10 T/A, then such waste can be stored up to a period of 180 days before disposal. In case of any violation, authorization granted shall be suspended / cancelled.

17. The industry / mine shall apply for renewal of authorization in Form - 1, 120 days before expiry of this authorization order enclosing Annual Return in Form - 4, Manifest copies in Form - 10 and compliance to the conditions stipulated in this order along with adequate processing fees.

18. In case of transportation of hazardous and other waste, the responsibility of safe transport shall be either of the sender or the receiver whosoever arranges the transport and has the necessary authorisation for transport from the concerned State Pollution Control Board. This responsibility should be clearly indicated in the manifest.

19. Hazardous Wastes having calorific value of more than 2500 Kcal/Kg shall not be land filled. It can only be disposed through authorized actual users or incinerated in authorized Hazardous Waste incinerator or co-processing in authorized cement kiln.

31/3

Member Secretary

To

The Dy Managing Director
Nuagaon Iron Ore Mine of
M/s JSW Steel Ltd.,
At – Nuagaon, PO :Guali, Barbil
Dist- Keonjhar, Odisha

Memo No. 5323 Dt. 31-03-2022

Copy to the:

1. Collector & District Magistrate, **Keonjhar**
2. Director, Factories & Boilers, Odisha, **Bhubaneswar**.
3. Regional Officer, State Pollution Control Board, Odisha, **Keonjhar.**
4. Guard file.

31/3/2022

Senior Environmental Engineer

Steel Limited

Regd. Office: JSW Centre
Bandra Kurla Complex,
Bandra (East), Mumbai – 400 051
CIN : L27102MH1994PLC152925
Phone : +91 22 4286 1000
Fax : +91 22 4286 3000
Website : www.jsw.in

No. JSW/S/O/2022/444 Date: 21/06/2022

To,
The Member Secretary,
State Pollution Control Board, Odisha
Paribesh Bhawan, A/118, Nilakantha Nagar,
Unit-8, Bhubaneswar, Odisha-751012.

Sub: - Submission of Hazardous Waste Annual Return (Form 4) in respect of **Nuagaon Iron Ore Mine of M/s JSW Steel Ltd for the period April 2021 to March 2022**.

Dear Sir,

We would like to submit that M/s JSW Steel Limited has been granted mining lease the Nuagaon Iron Ore block after emerging as the 'Preferred Bidder' in the e-auction conducted by the State Government of Odisha in March, 2020.

We have obtained the Hazardous waste authorization vide letter number **IND-IV-HW-1348/5322** dated 31.03.2022 and valid for a period of 1 year.

We are submitting herewith annual return of Hazardous Waste in Form 4 of Nuagaon Iron Ore Mine, M/s JSW Steel Ltd. for the period April 2021 to March 2022.

Seeking your co-operation as always.

Thanking you,

Yours Faithfully
For JSW Steel Ltd

Baswaraj M Dalgade
(Authorized Signatory)

Copy to: The Regional Officer, State Pollution Control Board, Baniapat, DD College Road, Keonjhar, Odisha-758001.

FORM 4

[See rules 6(5), 13(8), 16(6) and 20(2)]

FORM FOR FILING ANNUAL RETURNS

[To be submitted to State Pollution Control Board by 30th day of June of every year for the preceding period April-2021 to March-2022]

1. Name and address of facility	:	M/s JSW Steel Ltd Nuagaon Iron Ore Mine in villages Nuagaon, Barapada, Gandhalpada, Guali, Katesahi, Parediposi, KohlaRudukela, Panduliposhi and Topadihi villages under Barbil Tehsil of Keonjhar District, Odisha state
2. Authorization No. and Date of issue	:	HWA No L.No. IND-IV-HW-1348/5322 Dated 31.03.2022 (valid for 1 year)
3. Name of the authorised person and full address With telephone, fax number and e-mail	:	Mr. Baswaraj Dalgade AGM-Projects JSW Steel Ltd, Tehsil-Barbil, District - Keonjhar (Odisha) Pin: 758035 Email: baswaraj.dalgade@jsw.in; Mobile: +91 9934311367
4. Production during the year (product wise), Wherever applicable	:	6264155.00 Iron Ore (ROM)

Part A. To be filled by hazardous waste generators

1. Total quantity of waste generated category wise	:	**As per Annexure - I**
2. Quantity dispatched		
(i) to disposal facility	:	Nil
(ii) to recycler or co-processors or pre-processor	:	
(iii) others	:	
3. Quantity utilised in-house, if any -	:	Nil
4. Quantity in storage at the end of the year –	:	Nil

Part B. To be filled by Treatment, storage and disposal facility operators

1. Total quantity received -	:	**Not Applicable**
2. Quantity in stock at the beginning of the year -		

3. Quantity treated –

4. Quantity disposed in landfills as such and after treatment –

5. Quantity incinerated (if applicable) – **Not Applicable**

6. Quantity processed other than specified above - **Not Applicable**

7. Quantity in storage at the end of the year –

Part C. To be filled by recyclers or co-processors or other users

1. Quantity of waste received during the year – **Not Applicable**
   (i) domestic sources
   (ii) imported (if applicable)- **Not Applicable**

2. Quantity in stock at the beginning of the year -

3. Quantity recycled or co-processed or used –

4. Quantity of products dispatched (wherever applicable) – **Not Applicable**

5. Quantity of waste generated - **Not Applicable**

6. Quantity of waste disposed - **Not Applicable**

7. Quantity re-exported (wherever applicable)- **Not Applicable**

8. Quantity in storage at the end of the year – **As per Annexure - I**

Signature of the Occupier

Date: 21.06.2022

Place: Nuagaon Iron Ore Mine

Part A. To be filled by hazardous waste generators

Annexure-1

S.N.	Type of Hazardous Waste	Category		Unit	Approved Quantity as per CCA*	Total Qty. of generated category wise in FY 21-22	Quantity dispatched			Quantity utilized in house	Quantity in storage at the end of year	Description of treatment
		Sch	Code				To disposal facility	To recyclers / co-processors or pre-processor	Other			
1	Used or spent oil*	I	5.1	T/A	15	10.35	0	22.77	0	0	2.94	Sold to register recycler
2	Contaminated Cotton Rags And other cleaning materials	I	33.2	T/A	100	0.749	0	0	0	0	0.749	Stored
3	Discarded containers/ barrels/ liners contaminated with hazardous wastes/ chemicals	I	33.1	T/A	100	10.479	0	0	0	0	10.479	Stored

*As per Hazardous Waste Authorization

FORM 10

[See rules 19(1)]

MANIFEST FOR HAZARDOUS AND OTHER WASTE

1.	Sender's Name & Mailing Address (Including Phone No & email)	:	M/S. JSW Steel Ltd. Nuagaon Iron Ore mines. At-Nuagaon. Po-Guali, Barbil. Dist-Keonjhar. odisha.
2.	Senders authorization No.	:	IND-IV-HW-1348/5322 dt 31.03.2021
3.	Manifest Document No.	:	
4.	Transporter's Name & Address (including Phone No. and email)	:	Self
5.	Type of Vehicle	:	(~~Truck~~ / Tanker / Special Vehicle)
6.	Transporter's Registration No.	:	NIL
7.	Vehicle. Registration No.	:	OD-01-J-8282
8.	Receiver's Name & mailing Address (Including phone No and email)	:	M/S. Swaraj Lubricants. At-Gobinda PO-Haldipada. Dist-Balasore. odisha. swarajlubricants@twister.co.in
9.	Receiver's authorisation No.	:	IND-IV-HW-1028/4048 dt 31.03.2018
10.	Waste Description	:	Used Lub Oil.
11.	Total Quantity No. of Containers	:	6.72 KL ~~m3~~ or ~~MT~~ or KL 32 Nos.
12.	Physical form	:	Solid/Semi-Solid/Sludge/~~Oily~~/Tarry/Slurry/Liquid
13.	Special handling instructions and additional information	:	a) Keep the material dry b) Never transport while hot and wet c) Avoid skin and eye contact d) Store in a dry and covered area e) Use safety shoes, helmet and goggles
14.	Sender's Certificate	:	I hereby declare that the contents of the consignment are fully and accurately described above by proper shipping name and are categorized, packed, marked and labeled, and are in all respect in proper condition for transport by road according to applicable national government regulations.
	Types Name & Stamp (JSW STEEL LIMITED BARBIL) — Signature: Alok Pathak		Month: 1 0 — Day: 1 7 — Year: 2 0 2 2
15.	Transporter Acknowledgment of Receipt of Wastes		
	Name & Stamp — Signature: Pattanayak		Month: 1 0 — Day: 1 7 — Year: 2 0 2 2
16.	Receivers Certification for Receipt of Hazardous and other waste		
	Name & Stamp (SWARAJ LUBRICANTS, BALASORE 756027, GOBINDA PO-HALDIPADA, INDIA) — Signature: Pattanayak		Month: 1 0 — Day: 1 7 — Year: 2 0 2 2

FORM 9

[See rule 18 (2)]

TRANSPORT EMERGENCY (TREM) CARD

[To be carried by the transporter during transportation of hazardous and other wastes, provided by the sender of waste]

1. Characteristics of hazardous and other wastes:

Sl. No.	Type of waste	Physical properties	Chemical properties	Exposure hazardous	First Aid requirements
1	Used Oil	1.Colour- Black 2.Lube oil 3.Viscois in nature	Branched Alkanes, Cycloalkanes, Benzene, Polly Aromatic Hydro carbons, decomposition products	Skin corrosion/ Irritation, Sensitization- Respiratory, Carcinogenicit y	IF INHALED: Remove person to fresh air and keep comfortable for breathing. IF ON SKIN: Wash with plenty of soap and water. IF IN EYES: Rinse cautiously with water for several minutes. IF SWALLOWED: Immediately call poison centre / doctor/ physician.

2. Procedure to be followed in case of fire: Move to safe distant place and immediately inform to the nearest fire station.
3. Procedure to be followed in case of spillage/ accident/ explosion: Move to a safe distant place and immediately inform to the nearest fire station.
4. For expert service, please contact:

(i) Name and Address : JSW Steel ltd Nuagaon Iron ore mines

(ii) Telephone No. :

JSW STEEL LIMITED BARBIL

Alok Pathak

M/S. Swaraj Lubricants
At-Gobinda. Po. Haldipada.
Dist-Balasore. odisha.
9437283861

SWARAJ LUBRICANTS BALASORE 756027 ODISHA INDIA AT-GOBINDA PO-HALDIPADA

(Name, contact number & signature of sender)

Date: 17.10.2022

Place: Nuagaon

3rd Pass Book

Passbook for Maintenance of Records of Hazardous and Other Wastes purchased by the Actual User [See Rule – 6(7& 8) of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016]

Name and Address of the Actual User: M/S Swaraj Lubricants At-Gobinda, PO-Haldipada, Dist-Balasore, Odisha

Telephone No.: 9437054683 E-mail: swarajlubricants1@gmail.com

Reference of Authorisation No. 4048 Date: 31-03-2018

Passbook No: IND/IV/HW/1028/16/2021 Date: 31-05-2021

Validity Till: As per Authorisation Order.

Type & Quantity of Hazardous and Other WastesPermitted for Procurement and processing for Reuse, Recycling, Recovery, Preprocessing, Utilisation including Co-Processing

Sl. No	Type of Hazardous and Other Wastes	Quantity
1.	Used oil	1500 KL/A
2.	Waste Oil	6000 KL/A

This Passbook is valid till Authorisation under Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 is valid. Therefore, both Authorisation Order as well as Passbook shall be produced before the occupier of an establishment who generates Hazardous and Other Wastes for procurement.

28/5/21

Member Secretary
Seal:

FORM – 3

[See Rule 9(1)]

Format for maintaining records of hazardous waste at the facility

1. Name and address of the occupier or operator of a facility: Nuagaon Iron ore mines
2. Date of issuance of authorisation and its reference number: 31-03-2022, IND-IV-HW-1348/5322
3. Description of hazardous waste:

Physical form with description	Chemical form	Total volume and weight (in tonnes)
Used oil 1. Colour- Black 2. Lube oil 3. Viscous in nature	Branched Alkanes, Cycloalkanes, Benzene, Polly Aromatic Hydrocarbons, decomposition products	9.114

4. Description of storage and treatment of hazardous waste:

Date	Method of storage of hazardous wastes	Date	Method of treatment of hazardous wastes
5-12-2022	Storage on impervious floor under well ventilated covered shed followed by disposal through original actual users authorized by SPCB, Odisha	-	-

5. Details of transportation of hazardous waste:

Name & address of consignee of package	Mode of packing/of the waste for transportation	Mode of transportation to site of disposal	Date of transportation
M/S Raj Lubricants Januganj Baleshwar 756019 odisha	BARREL	Road	27-1-2023

6. Details of disposal of hazardous waste:

Date of disposal	Concentration of hazardous material in the final waste form	Site of disposal (identify the location on the relevant layout drawing for reference)	Method of disposal	Persons involved in disposal
-	-	-	-	-

7. Data of environmental surveillance:

Analysis of ground water			Analysisof soil samples			Analysis of air sampling		
Date of sampling	Location of sampling	Data	Date of sampling	Location of Sampling	Data	Date of sampling	Location of sampling	Data
23-11-2022	Rengelabeda village Nuagaon village Barpada village Katesahi village Malda village Guali village Panduliposhi village	The test results are within the standards as per IS10500:2012	16-12-2022	Mines office	The analysis conducted for 17 parameters were within the range.	16-12-2022	Mines office Near LP99 Near katasahi exit gate Dispensary	Average value of PM_{10} = 43.75 µg/m3 $PM_{2.5}$ = 16.1 µg/m3 SO_2 = 14.2 µg/m3 NO_2 = 13.2 µg/m3 CO = 0.46 mg/m3

8. Details of the hazardous wastes reused and recycled:

Date	Total quantity of hazardous waste generated	Details of hazardous waste minimization activity	Material received	Final quantity of waste generated	Net reduction in waste generation quantity and percentage
-	-	-	-	-	-

Place: NUAGAON

Signature: Sindhuja CB

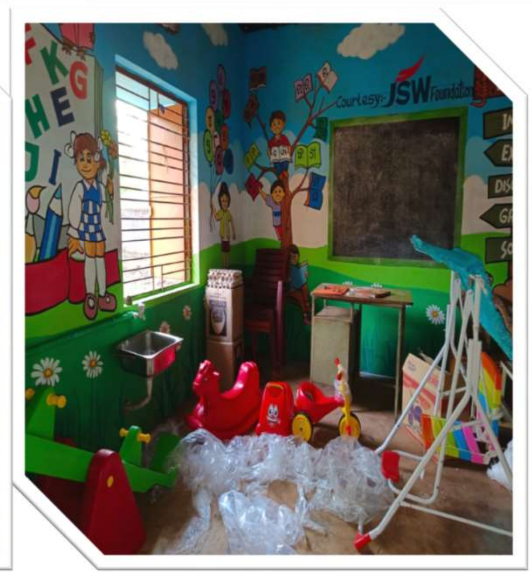
Date:27-01-2023

Designation: Assistant Manager

Sustainable Development







Community development

Water supply and Sanitation

Medical Facilities

(FORM - O)

(See rule 29F (2) and 29L)

Report of medical examination under rule 29B

(To be issued in Triplicate)

Certificate No JSW/OHC/2022/I-252

Certified that Shri/Shrimati* Swapan Gayen

employed as ASSISTANT MANAGER In NUAGAON IRON ORE mines,

Form A No. 51 has been examined for an Initial/Periodical medical examination. He/she* appears to be 34 years of age. The findings of the examining authority are given in the attached sheet. It is considered that Shri/Shrimati* Swapan Gayen

(a)* is medically fit for any employment/ graduate/technician apprentice training in mines.

~~(b)* is suffering from..................................... and is medically unfit for~~

~~(1) any employment in mine; or~~

~~(2) any employment below ground; or~~

~~(3) any employment or work..........~~

~~(c)* is suffering from.................................. and should get this disability* cured/controlled and should be again examined within a period of ....months. He/ She will appear for re - examination with the result of test of.....................................and the opinion of .... Specialist from .... He/She* may be permitted/not* permitted to carry on his duties during this period.~~

Dr. Santosh Kumar Mishra
MBBS, MD, AFIH(CLI)
Occupational Health Physician
Regd. No- 16388/2007 (Odisha

Signature of the Examining Authority

DR SANTOSH KU MISHRA

(Name and Designation in Block letters)

Place:

Date: 03.05.2022

---

* Delete whatever is not applicable.

** One copy of the certificate shall be handed over to the person concerned and another copy shall be sent to the manager of the mine concerned by registered post; and the third copy shall be retained by the examining authority.

Report of the Examining Authority

(To be filled in for every medical examination whether initial or periodical or re -examination or after cure/control of disability).

Annexure to **Certificate No.**... as result of medical examination on ....

Identification Mark **Left thumb impression of the candidate**

i. A cut mark on right hand thump.

ii.

1. General Development: Good/Fair/Poor
2. Height.....167.....CMS
3. Weight.....70...... Kg
4. **Eyes:**
   (i) Visual Actuality-Distant vision (with or without glasses).
   Right Eye..............6/6..... Left Eye........6/6............
   (ii) Any Organic disease of eyes:
   (iii) Night Blindness :
   (iv) Color Blindness : } No
   (v) Squint* :
   (* to be tested in special case)
5. **Ears:**
   (i) Hearing Right Ear..........15 (dB)..... Left Ear........15 (dB)..........
   (ii) Any Organic Disease:
6. **Respiratory System:**
   Chest measurement
   (i) After full Inspiration.........95.........cms
   (ii) After full Expiration ....91.........cms
7. **Circulatory System:**
   Blood Pressure: 122/82 mm/Hg.
   Pulse : 78/min
8. **Abdomen:**
   - Tenderness No
   - Liver Non
   - Spleen Non
   - Tumor No
9. **Nervous System:**
   - History of Fits or epilepsy No
   - Paralysis No
   - Mental Health
10. Locomotor System: } Non
11. Skin:
12. Hernia:
13. Hydrocele: } No
14. Any Other Abnormality
15. **Urines:**
    - Reaction Acidic
    - Albumin Nil
    - Sugar Nil
16. Skiagram of Chest:
17. Any other "C" test considered necessary by the examining authority. No
18. Any opinion of Specialist considered necessary: No

Dr. Santosh Kumar Mishra
MBBS, MD, AFIH(CLI)
Regd. No- 16388/2007 (Odisha

Place: **(Signature of the examining Authority)**

Report of Medical Examination as per the recommendations of National Safety Conferences in Mines

(To be used in continuation with Form O)

Certificate No: JSW/OHC/2022/I-252
Name : Swapan Gayen
Identification Marks:

1. Cardio logical Assessment:

Auscultation	S1	Normal
	S2	Normal
	Additional Sound	No
Electrocardiograph (12 leads) findings :		Normal/Abnormal

Enclosed ECG

2. Neurological Assessment:

Findings	Normal/Abnormal
Superficial Reflexes	Nor
Deep Reflexes	Nor
Peripheral Circulation	Nor
Vibrational Syndromes	N

3. ILO Classification of Chest Radiograph:

Profusion of Pneumoconiosis opacities	Grades	Types
Present/Absent	0/0	

Enclosed Chest Radiograph

4. Audiometry Findings:

Conduction Type	Left Ear	Right Ear
Ear Conduction	Normal/Abnormal	Normal/Abnormal
Bone Conduction	Normal/Abnormal	Normal/Abnormal

Enclosed Audiometry Report:

5. Pathological/Microbiological Investigations:

SI.No.	Tests	Findings
1	Blood-Tc,Dc,Hb,ESR, Platelets	WNL/Abnormal
2	Blood Sugar- Fasting & PP	WNL/Abnormal
3	Lipid profile	WNL/Abnormal
4	Blood Urea, Creatinine	WNL/Abnormal
5	Urine Routine	WNL/Abnormal
6	Stool Routine	WNL/Abnormal

Enclosed Investigation Reports.

6. Special Tests for MN exposure:

Behavioral Disturbances		Present/Not Present
Speech Defect		Present/Not Present
Neurological Disturbances	Tremor	Present/Not Present
	Adiadocokinesia	Present/Not Present
	Emotional Changes	Present/Not Present

7.Any other Special Test Required:

Dr. Santosh Kumar Mishra
MBBS, MD, AFIH(CLI)
Occupational Health Physician
Regd. No- 16388/2007 (Odisha

Signature of the EX

Awareness program on Occupational Health

Steel Limited

Regd. Office: JSW Centre
Bandra Kurla Complex,
Bandra (East), Mumbai – 400 051
CIN : L27102MH1994PLC152925
Phone : +91 22 4286 1000
Fax : +91 22 4286 3000
Website : www.jsw.in

No. JSW/S/O/2021/194 Date: 18/08/2021

To,
The Sarpanch,
Loidapada Gram Panchayat

Sub: - Submission of Environment Clearance letter for the **Nuagaon Iron Ore Mine of M/s JSW Steel Ltd.**

Ref: - Environment Clearance Letter No F. No. J-11015/1156/2007-IA.II (M) dated 05.08.2021 issued by MOEF&CC, GOI.

Dear Sir,

With reference to aforesaid subject, we would like to submit that M/s JSW Steel Limited has obtained the Environment Clearance for Nuagaon Iron ore mine for expansion in Iron Ore production from 5.2 Million TPA to 7.99 Million TPA (ROM) along with existing 2.0 Million TPA Beneficiation Plant and Crusher and Screen Plants in the mine lease area of 767.284 Ha located in the village(s) of Nuagaon, Guali, Topadihi, Barapada and Katasahi, Tehesil- Barbil, Keonjhar District, Odisha from MOEF&CC, GOI on 05.08.2021.

To comply the EC Standard condition (I. Statutory Compliance point no 5), a copy of environment clearance is submitted for your kind record and perusal.

Thanking you,

Yours Faithfully
For JSW Steel Ltd

Baswaraj M Dalgade
(Authorized Signatory)

Encl: As above

Steel Limited

Regd. Office: JSW Centre
Bandra Kurla Complex,
Bandra (East), Mumbai – 400 051
CIN : L27102MH1994PLC152925
Phone : +91 22 4286 1000
Fax : +91 22 4286 3000
Website : www.jsw.in

No. JSW/S/O/2021/195

Date: 18/08/2021

To,
The Sarpanch,
Guali Gram Panchayat

Sub: - Submission of Environment Clearance letter for the **Nuagaon Iron Ore Mine of M/s JSW Steel Ltd.**

Ref: - Environment Clearance Letter No F. No. J-11015/1156/2007-IA.II (M) dated 05.08.2021 issued by MOEF&CC, GOI.

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Thanking you,

Yours Faithfully
For JSW Steel Ltd

Baswaraj M Dalgade
(Authorized Signatory)

Encl: As above

"Pujas are to be conducted in an indoor-like condition only for observance of rituals without public participation" SRC order

GOVERNMENT LOCKS ALL FESTIVALS

No public celebration of Pujas this year too

EXPRESS NEWS SERVICE @ Bhubaneswar

WITH the Covid pandemic still raging across the State, the Odisha government on Monday said there will be no public celebration of festivals across the State including Ganesh Puja, Durga Puja, Laxmi Puja and Kali Puja this year too.

However, festival rituals in temples and other places of worship will continue as usual with a limited persons. Ganesh Puja has been allowed in educational institutions but with participation of a limited number of students and strict adherence to Covid norms.

Releasing the guidelines, Chief Secretary Suresh Mahapatra said, "It is not possible to adhere to Covid appropriate behaviour during celebration of puja festivals and congregations have potential to cause spread of the virus. Pujas are to be conducted in an indoor-like condition only for observance of rituals without public participation."

For conducting puja in pandals and mandaps, the organisers will have to get necessary permission from the district magistrate or any other officer authorised by him. In Bhubaneswar and Cuttack, permission will be given by the Commissioner of Police of the two cities or any other officer authorised by him.

The guidelines issued by the office of the Special Relief Commissioner (SRC) said that there should be no more than seven persons including organisers and priests and support staff present in the puja pandal or mandap. "There will be no public darshan for devotees. Puja pandals or mandaps have to be covered on three sides. The fourth side shall also be covered in a way not to allow any public view of the idols. The size of idols should be less than four feet and no public address system is allowed," the SRC order said.

The persons present at puja pandal or mandap will have to follow all Covid protocols and abide by any other conditions as imposed by local administration.

The SRC order said that there would be no immersion procession and idols will be immersed in artificial ponds created by the local administration. Community feasts associated with the festivals or pujas have also been banned.

"Any person found violating the guidelines will be punished in accordance with the provisions of Section 51 to 60 of the Disaster Management Act, 2005 and the Epidemic Diseases Act, 1897 besides legal action under Section 188 of IPC and other legal provisions as applicable," the order added.

FESTIVE SEASON UNDER VIRUS SHADOW

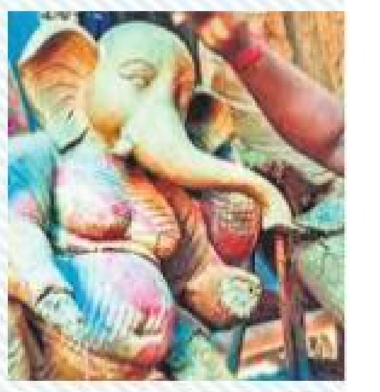
Ganesh Puja, Durga Puja, Laxmi Puja and Kali Puja

CP to allow festivals at mandap in Twin City

Permission from Collector must

Idol height in mandap or pandal - 4 ft or less

Only 7 persons to be allowed in a mandap or pandal



Lawyers suspend boycott of Chief Justice court

EXPRESS NEWS SERVICE @ Cuttack

THE Orissa High Court Bar Association (OHCBA) on Monday suspended its boycott of the Chief Justice's court.

OHCBA member lawyers were boycotting the Chief Justice's court since live streaming of the court proceedings was started on August 2. The live streaming of the proceedings was started on trial basis on that day and then discontinued till another trial run on Monday from 2 pm.

The association has been demanding immediate withdrawal of the High Court of Orissa Live Streaming of Court Proceedings Rules, 2021 as it was implemented without taking into consideration the views and suggestions of the association and the pros and cons.

OHCBA secretary JK Lenka said the decision to suspend abstention of the court of Chief Justice by member lawyers was taken by the general body.

A final decision will be taken after a meeting with the Chief Justice, he said and added that a committee formed for the purpose will represent OHCBA at the meeting to be held soon.

Rent-free land for Bagchi Cancer Centre gets Cabinet approval

EXPRESS NEWS SERVICE @ Bhubaneswar

THE State Cabinet on Monday approved the Revenue department's proposal to provide government land measuring 20 acre each in Infocity-II for establishment of Bagchi-Sri Shankar Cancer Centre and Research Institute, and Bagchi Karunashraya Palliative Care Centre on payment of a token ₹1 per annum towards annual ground rent and cess.

The Cabinet meeting chaired by Chief Minister Naveen Patnaik also decided to waive off stamp duty and registration fees amounting ₹2.92 crore for execution of lease deed of the land in Chandihata mouza of Khurda district.

Chief Secretary Suresh Mahapatra said the State government is committed to fulfil the healthcare needs of the people in an equitable, efficient, transparent and time-bound manner.

The Cabinet further approved the proposal for lease of 18.23 acre of government land in Kalamati mouza under Sambalpur tehsil in favour of the Director, IIM Indore and Mentor Director, IIM Sambalpur for establishment of a permanent campus of IIM Sambalpur.

The land is given free of premium and incidental charges subject to payment of ₹100 per acre per annum towards annual ground rent and cess at the rate of 75 per cent of the ground rent. The government would have to forgo over ₹4.21 crore on non-recurring basis (one time) and another ₹6.67 lakh on recurring basis.

In a separate decision, the Cabinet approved the lowest turnkey tender of TATA Projects Ltd amounting to ₹331.28 for execution of Shree Mandira Parikrama project in the heritage city of Puri under ABADHA scheme. The work is targeted for completion within a period of 18 months, Mahapatra said.

The Cabinet also approved 16 proposals including appointment of Anjan Kumar Manik, retired IAS officer, as member in the Odisha Public Service Commission.

OTHER DECISIONS

Proposal for lease of 18.23 acre of govt land to IIM Sambalpur

Lowest turnkey tender of TATA Projects Ltd for execution of heritage plan in Puri

Appointment of retired IAS officer Anjan Manik as member in OPSC

The State government is committed to fulfil the healthcare needs of the people in an equitable, efficient, transparent and time-bound manner

Suresh Mahapatra, Chief Secretary

18 dists are educationally backward

EXPRESS NEWS SERVICE @ Bhubaneswar

OF the 374 educationally backward districts in the country, 18 are in Odisha. This was informed by Union Education Minister Dharmendra Pradhan while replying to a question in the Lok Sabha by MPs Rama Devi and Harish Dwivedi.

An expert committee constituted by the University Grants Commission (UGC) has identified these districts based on various educational parameters including gross enrollment ratio, college population ratio and average enrollment per college.

The districts are Angul, Balangir, Bargarh, Boudh, Deogarh, Dhenkanal, Gajapati, Ganjam, Kalahandi, Kandhamal, Keonjhar, Koraput, Malkangiri, Nabarangpur, Nayagarh, Nuapada, Rayagada and Sonepur.

As per UGC, Odisha has the highest number of educationally backward districts compared to its neighbour Andhra Pradesh which has 11 such districts, Chhattisgarh (15), Jharkhand (12) and West Bengal (17).

The Union Minister informed that the Centre has taken a number of measures to improve the educational standards in the country with special focus on the educationally backward districts. The measures include integrated scheme for School Education - Samagra Shiksha - that enables all children to have access to quality education with an equitable and inclusive classroom environment. The scheme covers 11.6 lakh schools, over 15.6 crore students and 57 lakh teachers of government and aided schools.

EXPRESS READ

Six held with brown sugar worth over ₹1 cr

Cuttack: Commissionerate Police on Monday arrested six persons and seized 1.159 kg brown sugar worth over ₹1 crore from them. The accused are Debasis Das (23) of Kujang, Ullash Chandra Das (45) of Jamudanda, Lara Bhoi (25) of Alana Hata, Muna Sahu (31) of Alana Hat Teli Sahi in Jagatsighpur, Chaturbhuja Barik (27) of Satapola in Puri and Manas Chand (26) of Sahebzada Bazar in Cuttack. Briefing media persons, Commissioner of Police Soumendra Priyadarshi said acting on specific intelligence input about assembling of some drug peddlers at the backside of RNT School for supplying brown sugar to local dealers, a team of Lalbag police along with the special squad raided the spot and apprehended the accused with two motorcycles. During search, six polythene pockets containing 1.159 kg brown sugar worth ₹1.10 crore were seized from them. The accused used to procure the contraband from Balasore and supplied to dealers in different districts.

ମାଲବାହୀ ରେଳର ୧୩ ଡବା ଧାରଣାଚ୍ୟୁତ

ଭଦ୍ରକ,୧୦ା୮ (ସପ୍ର): ଭଦ୍ରକ ଚରମ୍ପାସ୍ଥିତ ଧାମରା ରେଳ ପୋଲ ନିକଟରେ ରେଳ ଧାରଣାଚ୍ୟୁତ ହୋଇଥିବା ଜଣାପଡ଼ିଛି। ଖାଲି ଥିବା ରେଳଟି ଧାମରା ଅଭିମୁଖେ ଯାଉଥିବା ସମୟରେ ଅପରାହ୍ଣ ୨ଟାରେ ଏଭଳି ଅଘଟଣ ଘଟିଛି। ରେଳରେ ମୋଟ ୬୦ଟି ଡବା ଥିଲା। ଏଥିମଧ୍ୟରୁ ୧୩ଟି ଡବା ଧାରଣାଚ୍ୟୁତ ହୋଇଛି। ତେବେ ରେଳ ଇଞ୍ଜିନ ସୁରକ୍ଷିତ ରହିଛି। ଖବର ଲେଖା ହେବାବେଳକୁ ରେଳବାଇର ଏକ ସ୍ୱତନ୍ତ୍ର ଦଳ ପହଞ୍ଚି ସ୍ଥିତି ଅନୁଧ୍ୟାନ କରୁଛନ୍ତି।

ହାଜର ହେଲେନି ବର୍ଷା, ଅନୁଭବ; ଶୁଣାଣି ୧୮କୁ ଘୁଞ୍ଚିଲା

କଟକ,୧୦ା୮ (ବ୍ୟୁରୋ): କଟକ ପରିବାର ଅଦାଲତରେ ଆଜି ଅଭିନେତା ତଥା ସାଂସଦ ଅନୁଭବ ମହାନ୍ତି ଓ ଅଭିନେତ୍ରୀ ବର୍ଷା ପ୍ରିୟଦର୍ଶିନୀ ଅନୁପସ୍ଥିତ ଥିଲେ। ଫଳରେ ମାମଲା ଅନୁଭବଙ୍କ ତରଫରୁ ଦାୟର ଛାଡ଼ପତ୍ର ମାମଲାର ଶୁଣାଣି ଅଗଷ୍ଟ ୧୮କୁ ଧାର୍ଯ୍ୟ ହୋଇଛି। ଦିଲ୍ଲୀରେ ଥିବାରୁ ଅନୁଭବ ଆସି ପାରି ନଥିଲେ। ଅନ୍ୟପକ୍ଷରେ ବର୍ଷା ବ୍ୟକ୍ତିଗତ କାରଣରୁ ଅନୁପସ୍ଥିତ ରହିଥିବା ନେଇ ଉଭୟ ପକ୍ଷଙ୍କ ଓକିଲ ଅଦାଲତଙ୍କୁ ଅବଗତ କରିଥିଲେ। ଅନୁଭବ ଦିଲ୍ଲୀର ପଟିଆଲା ହାଉସ ପରିବାର ଅଦାଲତରେ ଛାଡ଼ପତ୍ର ପାଇଁ ଗଲା ବର୍ଷ ଜୁଲାଇ ୧୬ରେ କରିଥିବା ଆବେଦନ ସର୍ବୋଚ୍ଚ ନ୍ୟାୟାଳୟଙ୍କ ନିର୍ଦ୍ଦେଶରେ କଟକ ପରିବାର ଅଦାଲତକୁ ସ୍ଥାନାନ୍ତର ହୋଇଥିଲା।

କର୍ପୋରେସନ୍ ବ୍ୟାଙ୍କର ୫.୬ କୋଟି ଋଣ ଠକେଇ

ତ୍ରିଚିରୁ ଅଭିଯୁକ୍ତ ଗିରଫ

ଭୁବନେଶ୍ୱର,୧୦ା୮ (ନି.ପ୍ର): କର୍ପୋରେସନ୍ ବ୍ୟାଙ୍କର ୫.୬୨ କୋଟି ଟଙ୍କା ଠକେଇ ମାମଲାରେ ରାଜ୍ୟ ଅର୍ଥନୈତିକ ଅପରାଧ ଶାଖା ମୁଖ୍ୟ ଅଭିଯୁକ୍ତ ଏସ୍ କାଥେରିସାନଙ୍କୁ ତାମିଲନାଡୁର ତ୍ରିଚିରୁ ଗିରଫ କରିଛି। କୋଟି କୋଟି ଟଙ୍କା ଠକେଇ କରିବା ପରେ କାଥେରିସାନ୍ ତାମିଲ୍‌ନାଡୁ ତ୍ରିଚିପଲ୍ଲୀ ଜିଲାର ଥୁଭାକୁଡି ଥାନା ଅଧୀନ ଜ୍ଞାନାଓଲି ଗ୍ରାମକୁ ପଳାଇଥିଲେ। ତାଙ୍କୁ ଗତକାଲି ଗିରଫ କରିବା ପରେ ଅର୍ଥନୈତିକ ଅପରାଧ ଶାଖା ତ୍ରିଚିନାପଲ୍ଲୀସ୍ଥିତ ବିଚାର ବିଭାଗୀୟ ଦଣ୍ଡାଧୀଶ ନିକଟରେ ହାଜର କରିଥିଲା। କାଥେରିସାନଙ୍କୁ ପୁଲିସ ଜିମାରେ ଭୁବନେଶ୍ୱର ଅଣାଯାଇଛି। ଆସନ୍ତାକାଲି ସ୍ଥାନୀୟ ଉପଖଣ୍ଡ ବିଚାରବିଭାଗୀୟ ଦଣ୍ଡାଧୀଶ(ଏସ୍‌ଡିଜେଏମ୍)ଙ୍କ ନିକଟରେ କାଥେରାସାନଙ୍କୁ ହାଜର କରାଯିବ ବୋଲି ଜଣାପଡିଛି। ୫ ବର୍ଷ ପରେ ଅଭିଯୁକ୍ତଙ୍କୁ ଠାବ କରାଯାଇଛି। ବର୍ତ୍ତମାନର ୟୁନିଅନ୍ ବ୍ୟାଙ୍କ ତଥା କର୍ପୋରେସନ୍ ବ୍ୟାଙ୍କର ମୁଖ୍ୟ ପରିଚାଳକ କେ ଏନ୍ ନରସୀମାଙ୍କ ଅଭିଯୋଗକ୍ରମେ ଅର୍ଥନୈତିକ ଅପରାଧ ଶାଖା ୨୦୧୫ ଫେବୃଆରୀ ୯ରେ ମାମଲା ରୁଜୁ କରିଥିଲା। ଅଭିଯୋଗ ଅନୁସାରେ ୨୦୦୯ରେ 'ମେସର୍ସ ଜଗନ୍ନାଥ ଫାଇନାନ୍ସ ସର୍ଭିସେସ୍ ଲିମିଟେଡ'ର

ଗିରଫ କଲା ରାଜ୍ୟ ଅର୍ଥନୈତିକ ଅପରାଧ ଶାଖା

ପରିଚାଳନା ନିର୍ଦ୍ଦେଶକ ତଥା 'ମେସର୍ସ କେଏଏସ୍ ଫାଉଣ୍ଡେସନ୍'ର ମୁଖ୍ୟ ନିର୍ବାହୀ ଅଧିକାରୀ ଏସ୍ କାଥେରିସାନ୍ କର୍ପୋରେସନ୍ ବ୍ୟାଙ୍କରେ ୫ କୋଟି ଟଙ୍କାର ଏକ କୃଷି ଋଣ ପାଇଁ ଆବେଦନ କରିଥିଲେ। ରାଜ୍ୟର ବିଭିନ୍ନ ସ୍ୱୟଂ ସହାୟିକା ଗୋଷ୍ଠୀକୁ କୃଷି ଉପକରଣ ଯୋଗାଇ ଦେବା ଲାଗି ବ୍ୟାଙ୍କ ଏହି ଋଣକୁ ମଞ୍ଜୁର କରିଥିଲା। ମେସର୍ସ ଜଗନ୍ନାଥର ପରିଚାଳନା ନିର୍ଦ୍ଦେଶକ କାଥେରିସାନ୍ ଏହି ଋଣ ନେବା ପରେ ପରିଶୋଧ ବାବଦରେ କିଛି ମାସ କିସ୍ତି ପୈଠ କରିଥିଲେ। ୨୦୧୧ରେ ହଠାତ୍ କାଥେରିସାନ୍ କିସ୍ତି ଦେବା ବନ୍ଦ କରି ଦେଇଥିଲେ।

ବ୍ୟାଙ୍କ ପକ୍ଷରୁ ଏହି ଋଣ ବାବଦ ଖୋଳତାଡ଼ ଆରମ୍ଭ ହୋଇଥିଲା। ଏବେ ଏହି ଋଣ ୫.୬୨ କୋଟି ଟଙ୍କାରେ ପହଞ୍ଚିଛି। ବ୍ୟାଙ୍କ ପକ୍ଷରୁ ଖୋଳତାଡ଼ କରାଯିବା ବେଳେ କାଥେରିସାନ୍ ଋଣ ନେବା ଲାଗି ଯେଉଁ କାଗଜପତ୍ର ଦାଖଲ କରିଥିଲେ ସେସବୁ ଜାଲ୍ ବୋଲି ଜଣାପଡିଥିଲା। ସେଭଳି କୌଣସି ଚାଷ କାର୍ଯ୍ୟ ପାଇଁ ଉପକରଣ କିଣା ଯାଇ ନ ଥିବା ଜଣାଯାଇଥିଲା। ଠକେଇ ଉଦ୍ଦେଶ୍ୟରେ ଏହି ଜାଲିଆତି କରାଯାଇଥିବା ତଦନ୍ତ ବେଳେ ଜଣାପଡିଛି। ଏହି ଅର୍ଥକୁ କାଥେରିସାନ୍ ତାଙ୍କ ବ୍ୟକ୍ତିଗତ କାର୍ଯ୍ୟରେ ନିୟୋଜିତ କରିଥିଲେ।

ଝାରସୁଗୁଡ଼ା, ସୁବର୍ଣ୍ଣପୁରରେ ଆକ୍ରାନ୍ତ ଶୂନ

ଭୁବନେଶ୍ୱର,୧୦ା୮ (ନି.ପ୍ର): ପଶ୍ଚିମ ଓଡ଼ିଶାରେ କରୋନା ମହାମାରୀର ସ୍ଥିତି ଦୋହଲିଲାଣି। ପ୍ରତିଦିନ ଗୋଟିଏ ପରେ ଗୋଟିଏ ଜିଲା ଆକ୍ରାନ୍ତ ଶୂନ୍ୟ ହୋଇ ଚାଲିଥିବାବେଳେ ପ୍ରାୟ ଜିଲା ଏବେ ନିୟନ୍ତ୍ରଣ ବଳୟକୁ ଆସିଗଲାଣି। ଗତକାଲି ରାଜ୍ୟରେ ୫୬ହଜାର ୮୫୯ ନମୁନା ପରୀକ୍ଷା କରାଯାଇଥିବାବେଳେ ସେଥିରୁ ୧୦୪୧ ଆକ୍ରାନ୍ତ ଚିହ୍ନଟ ହୋଇଛନ୍ତି।

ରାଜ୍ୟରେ ଚିହ୍ନଟ ହେଲେ ୧୦୪୧; ୬୪ ମୃତ୍ୟୁ

ଝାରସୁଗୁଡ଼ା ଓ ସୁବର୍ଣ୍ଣପୁରରେ ଜଣେ ହେଲେ ଆକ୍ରାନ୍ତ ବାହାରି ନାହାନ୍ତି। ସେହିପରି ବରଗଡ଼ରେ ୩ ଜଣ ଆକ୍ରାନ୍ତ ଚିହ୍ନଟ ହୋଇଥିବାବେଳେ ବଲାଙ୍ଗୀର ଓ ବୌଦ୍ଧରେ ଜଣେ, ଗଜପତିରେ ୩, କଳାହାଣ୍ଡି, କୋରାପୁଟ ଓ କନ୍ଧମାଳରେ ୫ ଲେଖାଏଁ, ମାଲକାନଗିରିରେ ୩, ନବରଙ୍ଗପୁର ଓ ନୂଆପଡାରେ ୨ ଲେଖାଏଁ, ସମ୍ବଲପୁରରେ ୯ ଆକ୍ରାନ୍ତ ବାହାରିଛନ୍ତି। ପଶ୍ଚିମ ଓଡ଼ିଶାରେ ଏବେ ପ୍ରାୟ ସମସ୍ତ ଜିଲାରେ ସକ୍ରିୟ ଆକ୍ରାନ୍ତଙ୍କ ସଂଖ୍ୟା ଦୁଇ ଅଙ୍କ ଭିତରେ ରହିଛନ୍ତି। ଏହାବାଦ୍ ଖୋର୍ଦ୍ଧାରେ ସର୍ବାଧିକ ୩୮୩ ଜଣ ଚିହ୍ନଟ ହୋଇଥିବା ବେଳେ କଟକରୁ ୧୩୨ ବାହାରିଛନ୍ତି। କଟକରେ ସଂକ୍ରମଣ ଉପର ତଳ ହେଉଛି। କଟକ ଜିଲା ଧୀରେ ଧୀରେ ନିୟନ୍ତ୍ରଣ ବଳୟ ଭିତରକୁ ଆସୁଛି। ଅବଶିଷ୍ଟ ଜିଲାଗୁଡ଼ିକରେ ଆକ୍ରାନ୍ତ ଦୁଇଅଙ୍କ ଭିତରେ ରହିଛନ୍ତି। ଆଜିର ଆକ୍ରାନ୍ତଙ୍କ ମଧ୍ୟରୁ ୬୦୫ ଜଣ ସଙ୍ଗରୋଧ ଏବଂ ୪୩୬ଟି ସ୍ଥାନୀୟ ସମ୍ପର୍କରୁ ଚିହ୍ନଟ ହୋଇଛନ୍ତି। ଆଜିର ଆକ୍ରାନ୍ତଙ୍କୁ ନେଇ ରାଜ୍ୟର ଆକ୍ରାନ୍ତଙ୍କ ସଂଖ୍ୟା ୯ ଲକ୍ଷ ୮୮ ହଜାର ୯୯୭ରେ ପହଞ୍ଚି ଥିବାବେଳେ ୧୦ ହଜାର ୯୮୮ ଜଣ ଏବେ ଚିକିତ୍ସାଧୀନ ଅଛନ୍ତି।

ଅନ୍ୟପକ୍ଷରେ ଆଜି ୬୪ ଜଣଙ୍କ କରୋନାରେ ମୃତ୍ୟୁ ଘଟିଥିବା ସ୍ୱାସ୍ଥ୍ୟ ବିଭାଗ ପକ୍ଷରୁ ଦର୍ଶାଯାଇଛି। ଆଜିର ମୃତ୍ୟୁକୁ ନେଇ ରାଜ୍ୟରେ କରୋନା ମୃତ୍ୟୁ ସଂଖ୍ୟା ୬ହଜାର ୫୬୫ରେ ପହଞ୍ଚିଛି। ଏଥିରେ ସର୍ବାଧିକ ଖୋର୍ଦ୍ଧାରୁ ୨୦ ଜଣଙ୍କ ମୃତ୍ୟୁ ହୋଇଥିବାବେଳେ ସୁନ୍ଦରଗଡ଼ରୁ ୮, ବାଲେଶ୍ୱରରୁ ୬, କନ୍ଧମାଳରୁ ୪, କଟକ, ଯାଜପୁର, ମୟୂରଭଞ୍ଜ, ନୟାଗଡ଼ ଓ ପୁରୀରୁ ୩ ଜଣ ଲେଖାଏଁ, ଅନୁଗୋଳ, ଦେବଗଡ଼ ଓ ଝାରସୁଗୁଡ଼ାରୁ ୨ ଜଣ ଲେଖାଏଁ ଏବଂ ବଲାଙ୍ଗିର, ଢେଙ୍କାନାଳ, ଗଞ୍ଜାମ, ଜଗତସିଂହପୁର ଓ ସମ୍ବଲପୁରରୁ ଜଣେ ଲେଖାଏଁ ମୃତ୍ୟୁବରଣ କରିଛନ୍ତି।

୨.୯୨ ଲକ୍ଷ ହିତାଧିକାରୀ ନେଲେ ଟିକା

ଭୁବନେଶ୍ୱର,୧୦ା୮ (ନି.ପ୍ର): ରାଜ୍ୟରେ ଚାଲିଥିବା ଟିକାକରଣ ଅଭିଯାନରେ ମଙ୍ଗଳବାର ୨ ଲକ୍ଷ ୯୨ହଜାର ୮୦୪ ହିତାଧିକାରୀ ସାମିଲ ହୋଇଛନ୍ତି। ୧୫୮୫ କେନ୍ଦ୍ରରେ ହୋଇଥିବା ଟିକାଦାନ କାର୍ଯ୍ୟକ୍ରମରେ ସର୍ବାଧିକ ୧ଲକ୍ଷ ୯୯ହଜାର ୨୯୯ ପାନ ଟିକା କେବଳ ଯୁବବର୍ଗ ନେଇଛନ୍ତି। ଆଜିର ଏହି ଟିକାଦାନକୁ ନେଇ ରାଜ୍ୟର ସଂଖ୍ୟା ୧କୋଟି ୮୪ଲକ୍ଷ ୫ହଜାର ୪୯୩ରେ ପହଞ୍ଚିଛି। ଆସନ୍ତାକାଲି ୧୪୪୦ କେନ୍ଦ୍ରରେ ଟିକାକରଣ ହେବ। ଇତିମଧ୍ୟରେ ୬୩ହଜାର ୬୦୮ ଗର୍ଭବତୀଙ୍କୁ ଟିକାକରଣ ହେଲେଣି ବୋଲି ବିଭାଗ ପକ୍ଷରୁ କୁହାଯାଇଛି।

୨୩ରୁ ଏକକ ପିଜି ପ୍ରବେଶିକା ପରୀକ୍ଷା

ଭୁବନେଶ୍ୱର, ୧୦ା୮ (ନି.ପ୍ର): ଉଚ୍ଚଶିକ୍ଷା ବିଭାଗ ଅଧୀନସ୍ଥ ରାଜ୍ୟର ସମସ୍ତ ବିଶ୍ୱବିଦ୍ୟାଳୟ, ସ୍ୱୟଂଶାସିତ ମହାବିଦ୍ୟାଳୟ ଏବଂ ସ୍ନାତକୋତ୍ତର(ପିଜି) ଉପଲବ୍ଧ ଥିବା ଡିଗ୍ରୀ ମହାବିଦ୍ୟାଳୟରେ ପିଜି ପାଠ୍ୟକ୍ରମରେ ନାମଲେଖାଇବା ନିମନ୍ତେ ୨୩ ତାରିଖରୁ ଏକକ ସ୍ନାତକୋତ୍ତର ପ୍ରବେଶିକା ପରୀକ୍ଷା (ସିପିଜିଇଟି) ଅନୁଷ୍ଠିତ ହେବ। ଏନେଇ ବିଭାଗ ପକ୍ଷରୁ ବିଜ୍ଞାପନ ପ୍ରକାଶ ପାଇଛି। ପରୀକ୍ଷା ତିନିଟି ଅଧିବେଶନ (ସେସନ)ରେ କରାଯିବ। ପ୍ରଥମ ଅଧିବେଶନ ପୂର୍ବାହ୍ନ ୧୦ଟାରୁ ଆରମ୍ଭ ହୋଇ ସାଢେ ୧୧ଟା ପର୍ଯ୍ୟନ୍ତ ଚାଲିବ। ଦ୍ୱିତୀୟ ଅଧିବେଶନ ୧୨.୩୦ ମିନିଟରୁ ଅପରାହ୍ନ ୨ଟା ପର୍ଯ୍ୟନ୍ତ ଏବଂ ତୃତୀୟ ଅଧିବେଶନ ଅପରାହ୍ନ ୩ଟାରୁ ସାଢେ ୪ଟା ଯାଏଁ ଚାଲିବ। ପରୀକ୍ଷା ସେପ୍ଟେମ୍ବର ୩ରେ ଶେଷ ହେବ ବୋଲି ବିଭାଗ ପକ୍ଷରୁ ପ୍ରକାଶିତ ବିଜ୍ଞାପନରେ ଉଲ୍ଲେଖ କରାଯାଇଛି। କଳା, ବାଣିଜ୍ୟ ଏବଂ ବିଜ୍ଞାନ ବିଭାଗର ମୋଟ ୪୭ଟି ବିଷୟ ପାଇଁ ପ୍ରବେଶିକା ପରୀକ୍ଷା ଅନୁଷ୍ଠିତ ହେବ। ୨୩ ତାରିଖ ପ୍ରଥମ ଅଧିବେଶନରେ କଳା ଓ ବିଜ୍ଞାନ ବିଭାଗର ମାନବଶାସ୍ତ୍ର, ଦ୍ୱିତୀୟ ଅଧିବେଶନରେ ଭୂଗୋଳ ଏବଂ ତୃତୀୟ ଅଧିବେଶନରେ ଏମ୍‌ବିଏ(ବାଣିଜ୍ୟ ପ୍ରଶାସନ) ପରୀକ୍ଷା ରହିଛି। ୨୪ରେ ପ୍ରଥମ ଅଧିବେଶନରେ ପଦାର୍ଥ ବିଜ୍ଞାନ, ଦ୍ୱିତୀୟ ଅଧିବେଶନରେ ଏଲ୍‌ଏଲ୍‌ଏମ୍ ଓ ଇଲେକଟ୍ରୋନିକ୍ ଟେଲିକମ୍ୟୁନିକେସନ ଏବଂ ତୃତୀୟ ଅଧିବେଶନରେ ବାଣିଜ୍ୟ ବିଷୟର ପରୀକ୍ଷା ରହିଛି। ଏହିପରି ଭାବେ ୩ ତାରିଖ ପର୍ଯ୍ୟନ୍ତ ଅନ୍ୟାନ୍ୟ ବିଷୟଗୁଡିକ ପାଇଁ ପ୍ରବେଶିକା ପରୀକ୍ଷା କରାଯିବ ବୋଲି ବିଭାଗ ପକ୍ଷରୁ କୁହାଯାଇଛି।

୩ଟି ଅଧିବେଶନରେ ୩ ସେପ୍ଟେମ୍ବର ପର୍ଯ୍ୟନ୍ତ ଚାଲିବ

୧୭ ଯାଏ ଘୁଞ୍ଚିଲା ବି.ଟେକ୍ ପଞ୍ଜୀକରଣ

ଭୁବନେଶ୍ୱର, ୧୦ା୮ (ନି.ପ୍ର): ଓଡ଼ିଶା ଯୁଗ୍ମ ପ୍ରବେଶିକା ପରୀକ୍ଷା (ଓଜେଇଇ) ଦ୍ୱାରା ପରିଚାଳିତ ବି.ଟେକ୍ ପ୍ରବେଶିକା ପରୀକ୍ଷା ପଞ୍ଜୀକରଣ ଅବଧିକୁ ଆସନ୍ତା ୧୭ ତାରିଖ ପର୍ଯ୍ୟନ୍ତ ବୃଦ୍ଧି କରାଯାଇଛି। ଏନେଇ ମଙ୍ଗଳବାର ଓଜେଇଇ ପକ୍ଷରୁ ବିଜ୍ଞପ୍ତି ପ୍ରକାଶ ପାଇଛି। ପଞ୍ଜୀକରଣ ଶେଷ ତାରିଖ ଅଗଷ୍ଟ ୧୦ ଥିଲା। ପଞ୍ଜୀକରଣ ସମୟ ସୀମା ୧୭ ତାରିଖ ରାତି ୧୧.୫୯ ମିନିଟ ଥିବାବେଳେ ଦେୟ ଦାଖଲ ଅବଧି ୧୮ ତାରିଖ ରାତି ୧୧.୫୯ ମିନିଟ ରହିଛି। ଓଜେଇଇ ୱେବସାଇଟ୍ (www.ojee.nic.in) କୁ ଲଗଇନ କରି ଛାତ୍ରଛାତ୍ରୀ ପଞ୍ଜୀକରଣ କରିପାରିବେ। ଯେଉଁ ବିଦ୍ୟାର୍ଥୀ ପୂର୍ବରୁ ପଞ୍ଜୀକରଣ କରିସାରିଛନ୍ତି ଏହି ଅବଧି ମଧ୍ୟରେ ସେମାନେ ଚାହିଁଲେ ପରୀକ୍ଷା କେନ୍ଦ୍ର, ସହର ପରିବର୍ତ୍ତନ କରିପାରିବେ। ପରବର୍ତ୍ତୀ ସମୟରେ ଆଉ ଅବଧି ବୃଦ୍ଧି କରାଯିବା ସମ୍ଭାବନା ନାହିଁ ବୋଲି ବିଜ୍ଞପ୍ତିରେ ଉଲ୍ଲେଖ କରାଯାଇଛି।

ପାନୀୟଜଳ ପ୍ରକଳ୍ପକୁ ବିରୋଧକରି ପ୍ରଶାସନ-ଅଞ୍ଚଳବାସୀ ମୁହାଁମୁହିଁ

୩ ପଞ୍ଚାୟତରେ ୧୪୪ ଧାରା

ରାଜକନିକା,୧୦ା୮ (ନି.ପ୍ର): କେନ୍ଦ୍ରାପଡ଼ା ଜିଲ୍ଲା ରାଜକନିକା ବ୍ଲକର ଭାଗିଗଡ଼ାଠାରେ ଖରସ୍ରୋତା ନଦୀରୁ ଭଦ୍ରକ ଜିଲ୍ଲା ପାଇଁ ବୃହତ୍ ପାନୀୟ ଜଳ ପ୍ରକଳ୍ପ କାର୍ଯ୍ୟକୁ ତୀବ୍ର ବିରୋଧ କରିଛନ୍ତି ଅଞ୍ଚଳବାସୀ। ଏହାକୁ ନେଇ ମଙ୍ଗଳବାର ପୁଲିସ ପ୍ରଶାସନ ଓ ଅଞ୍ଚଳବାସୀ ମୁହାଁମୁହିଁ ସ୍ଥିତିରେ ରହିଛନ୍ତି। ଏଥିପାଇଁ ବରୁଣାଡ଼ିଆ ଛକ ନିକଟରେ ଉତ୍ତେଜନା ପରିସ୍ଥିତି ଲାଗିରହିଛି। ପରିସ୍ଥିତି ଏପରି ହୋଇଛି ଯେ ପ୍ରକଳ୍ପସ୍ଥଳ ନିକଟକୁ ଲାଗି ରହିଥିବା ଭାରିଗଡ଼ା, ବାଳକାଟି ଓ ବରୁଣାଡ଼ିଆ ପଞ୍ଚାୟତରେ

ଦୁଇ ପୂର୍ବତନ ବିଧାୟକଙ୍କ ସହ ଶତାଧିକ ଗିରଫ

ଆଜିଠାରୁ ୨ ମାସ ପର୍ଯ୍ୟନ୍ତ ୧୪୪ ଧାରା ଲାଗୁ କରାଯାଇଛି। ମଙ୍ଗଳବାର ସକାଳୁ ଏକ ହଜାରରୁ ଅଧିକ ମହିଳା, ଯୁବକ, ଚାଷୀ ୧୪୪ ଧାରାକୁ ଖାତିର ନକରି ଶୋଭାଯାତ୍ରାରେ 'ଜୀବନ ଦେବୁ, ପାଣି ଦେବୁ ନାହିଁ' ନାରା ଦେଇ ପ୍ରକଳ୍ପ କାର୍ଯ୍ୟ ବନ୍ଦ କରିବାକୁ ଅଡ଼ିବସିଥିଲେ। ବରୁଣାଡ଼ିଆ ଛକ ନିକଟରେ ପୁଲିସ ସେମାନଙ୍କୁ ବାଧା ଦେଇଥିଲା। ଆନ୍ଦୋଳନକାରୀ କଟକ-ଚାନ୍ଦବାଲି ରାସ୍ତା ଉପରେ ବସିରହି ପ୍ରକଳ୍ପ ସ୍ଥାନକୁ ଯିବା ପାଇଁ ଅଡ଼ି ବସିଥିଲେ। ଅପରାହ୍ଣ ୪ଟାରୁ ରାତି ପର୍ଯ୍ୟନ୍ତ ପୁଲିସ ଏବଂ ଗ୍ରାମାବାସୀଙ୍କ ମଧ୍ୟରେ ଛକାପଞ୍ଝା ଲାଗିରହିଥିଲା।

ବରୁଣାଡ଼ିଆ ରାସ୍ତାରେ ପୁଲିସ ସହ ମହିଳାମାନେ ମୁହାଁମୁହିଁ ହୋଇଥିଲେ। ପୁଲିସ ପ୍ରଶାସନ ସେମାନଙ୍କୁ ପ୍ରକଳ୍ପ ସ୍ଥାନକୁ ଯିବାକୁ ଛାଡ଼ି ନଥିଲା। ମହିଳାମାନେ ଟାୟାର ଜାଳି ରାସ୍ତା ଅବରୋଧ କରିଥିଲେ। ଏହି କାରଣରୁ ୮ ଘଣ୍ଟାରୁ ଅଧିକ ସମୟ ଧରି କଟକ-ଚାନ୍ଦବାଲି ରାସ୍ତା ଅବରୋଧ ହୋଇ ରହିଥିଲା। ଜିଲାପାଳ ଅମୃତ ଋତୁରାଜ ଓ ଆରକ୍ଷୀ ଅଧୀକ୍ଷକ ମାଦକର ସନ୍ଦୀପ

ସମ୍ପଦ ପ୍ରକଳ୍ପ କାର୍ଯ୍ୟ ସ୍ଥଳରେ ରହି ପରିସ୍ଥିତି ଅନୁଧ୍ୟାନ କରିଛନ୍ତି। ଘଟଣାସ୍ଥଳରେ ବରିଷ୍ଠ ଅଧିକାରୀଙ୍କ ସହ ୧୭ ପ୍ଲାଟୁନ୍ ପୁଲିସ ବଳ ମୁତୟନ ହୋଇଛନ୍ତି।

ମଙ୍ଗଳବାର ଭୋର ୪ଟାରୁ ପୁଲିସ ବଳ ସହିତ ପ୍ରକଳ୍ପ କାର୍ଯ୍ୟ କରୁଥିବା କମ୍ପାନୀ କର୍ମଚାରୀ ସୁରକ୍ଷା ବଳୟ ମଧ୍ୟରେ ଖରସ୍ରୋତା ନଦୀ କୂଳରେ ପହଞ୍ଚିଥିଲେ। ସେମାନେ ପ୍ରକଳ୍ପ କାର୍ଯ୍ୟ ଆରମ୍ଭ କରୁଥିବା ଜଣାପଡ଼ିବା ପରେ ସକାଳେ ଆଜି ପୂର୍ବତନ ବିଧାୟକ ଚୋଲଗୋବିନ୍ଦ ନାୟକ, ପୂର୍ବତନ ବିଧାୟକ ଦେବେନ୍ଦ୍ର ଶର୍ମା, ଖରସ୍ରୋତା ବଞ୍ଚାଅ ସଂଗ୍ରାମ ସମିତି ସଭାପତି ଦୁର୍ଯ୍ୟୋଧନ ମହାନ୍ତି ଏବଂ ସମ୍ପାଦକ ବିଧାନ ଦାସଙ୍କ ସମେତ ଶତାଧିକ ଲୋକ ୧୪୪ ଧାରା ସତ୍ତ୍ୱେ ଏକତ୍ର ହୋଇଥିଲେ। ବରୁଣାଡ଼ିଆ ଛକ ନିକଟରେ ରାସ୍ତା ଉପରେ ବସି ପ୍ରକଳ୍ପ କାର୍ଯ୍ୟକୁ ବିରୋଧ କରିଥିଲେ। ପରେ ପୁଲିସ ଦୁଇ ପୂର୍ବତନ ବିଧାୟକଙ୍କ ସହିତ ସଂଗ୍ରାମ ସମିତିର ସଭାପତି, ସମ୍ପାଦକ ଓ ସମିତିର ବହୁ ସଦସ୍ୟଙ୍କୁ ଗିରଫ କରିଥିଲା। ପୁରା ଅଞ୍ଚଳକୁ ପୁଲିସ ଘେରାବନ୍ଦୀ କରିବା ପରେ ପ୍ରକଳ୍ପ କାର୍ଯ୍ୟ ଆରମ୍ଭ ହୋଇଛି।

ସୂଚନାଯୋଗ୍ୟ, କେନ୍ଦ୍ରାପଡ଼ା ଜିଲ୍ଲା ରାଜକନିକା ବ୍ଲକ ଭାଗିଗଡ଼ାରେ ୮୯୨ କୋଟି ଟଙ୍କା ବ୍ୟୟରେ ପ୍ରସ୍ତାବିତ ମେଗା ପାନୀୟ ଜଳ ପ୍ରକଳ୍ପକୁ ଅନୁମତି ମିଳିଛି। ଏହି ପ୍ରକଳ୍ପ କାର୍ଯ୍ୟକାରୀ ହେଲେ ଭଦ୍ରକ ଜିଲ୍ଲାର ୪ ବ୍ଲକକୁ ପାନୀୟ ଜଳ ଯୋଗାଇ ଦିଆଯିବ। ତେବେ ଅଞ୍ଚଳବାସୀଙ୍କ କହିବା ମୁତାବକ ଏହି ପ୍ରକଳ୍ପ କାର୍ଯ୍ୟକାରୀ ହେଲେ ଖରସ୍ରୋତା ମୃତ ନଦୀରେ ପରିଣତ ହେବ ଓ ସମୁଦ୍ରର ଲୁଣିଆ ମାଡି ଆସି ଖରସ୍ରୋତା ପାଣି ଲୁଣି ହୋଇଯିବ। ଏଥିସହ ପାଣି ଅଭାବରୁ ଚାଷ କାର୍ଯ୍ୟ ବ୍ୟାହତ ହେବ। ତେଣୁ ପ୍ରକଳ୍ପକୁ ଖରସ୍ରୋତା ବଞ୍ଚାଅ ସଂଗ୍ରାମ ସମିତି ପକ୍ଷରୁ ପାଖାପାଖି ୨ ବର୍ଷ ହେବ ବିରୋଧ କରାଯାଉଛି।

ଆୟବହିର୍ଭୂତ ସମ୍ପତ୍ତି ଠୁଳ

ପରିସଂଖ୍ୟାନ ସହାୟକଙ୍କ ଘରେ ଚଢ଼ଉ

ପୁରୀ,୧୦ା୮ (ନି.ପ୍ର): ଆୟ ବହିର୍ଭୂତ ସମ୍ପତ୍ତି ଠୁଳ ଅଭିଯୋଗରେ ପୁରୀ ପୌରାଞ୍ଚଳ ସମନ୍ୱିତ ଶିଶୁ ବିକାଶ ପ୍ରକଳ୍ପରେ କାର୍ଯ୍ୟ କରୁଥିବା ପରିସଂଖ୍ୟାନ ସହାୟକ କୃଷ୍ଣଚନ୍ଦ୍ର ଜେନାଙ୍କ ଘରେ ମଙ୍ଗଳବାର ଦୁର୍ନୀତି ନିବାରଣ ବିଭାଗ ଚଢ଼ଉ କରିଛି।

ତାଙ୍କ କାର୍ଯ୍ୟାଳୟ ସମେତ ପୁରୀ, ଭୁବନେଶ୍ୱର ଏବଂ ବ୍ରହ୍ମଗିରି ବାସଭବନରେ ତିନୋଟି ଦଳ ଚଢ଼ଉ ଚଳାଇ ଚାଲିଛନ୍ତି। ଶ୍ରୀ ଜେନାଙ୍କର ଭୁବନେଶ୍ୱର ଓ ପୁରୀରେ ତିନିମହଲା କୋଠା, ୬ଟି ବାସପଯୋଗୀ ଜମି, ଦୁଇଟି ଚାରିଚକିଆ ଯାନ, ୧୦ଟି ମୋଟରସାଇକେଲ ଠାବ କରାଯାଇଥିଲା ବେଳେ ବିଭିନ୍ନ ବ୍ୟାଙ୍କରେ ସ୍ଥାୟୀ ଜମା ଆକାରରେ ୪୯ଲକ୍ଷ ଟଙ୍କା ଥିବା ଜଣାପଡ଼ିଛି।

ଏଥିସହ ବୀମା କମ୍ପାନୀରେ ୭.୫୯ଲକ୍ଷ ନିବେଶ ସହ ସ୍ଥାବର ଓ ଅସ୍ଥାବର ସମ୍ପତ୍ତି ଠାବ ହୋଇଛି। ଶ୍ରୀ ଜେନାଙ୍କର ସମସ୍ତ ସମ୍ପତ୍ତିର ପରିମାଣ ୧.୬୬ କୋଟି ଆକଳନ କରାଯାଇଛି। ଚଢ଼ଉ ଜାରି ରହିଥିବା ଦୁର୍ନୀତି ନିବାରଣ ସୂତ୍ରରୁ ଜଣାପଡ଼ିଛି।

୧୪ ପର୍ଯ୍ୟନ୍ତ ବିଜୁଳି ଘଡ଼ଘଡ଼ି ସହ ବର୍ଷା

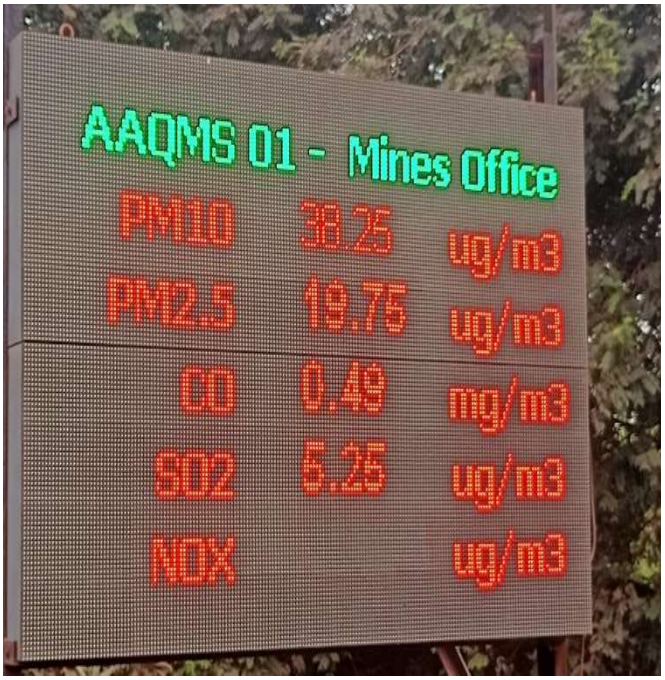
ଭୁବନେଶ୍ୱର, ୧୦ା୮ (ନି.ପ୍ର): ଆସନ୍ତା ୫ରୁ ୬ ଦିନ ପର୍ଯ୍ୟନ୍ତ ରାଜ୍ୟରେ ଦକ୍ଷିଣ ପଶ୍ଚିମ ମୌସୁମି ବାୟୁ ଦୁର୍ବଳ ରହିବ ବୋଲି ଭୁବନେଶ୍ୱର ଆଞ୍ଚଳିକ ପାଣିପାଗ କେନ୍ଦ୍ର ପକ୍ଷରୁ ଆକଳନ କରାଯାଇଛି। ବର୍ଷା ପରିମାଣ କମିବା ଯୋଗୁଁ ରାଜ୍ୟରେ ନିଅଣ୍ଟିଆ ବର୍ଷା ବୃଦ୍ଧି ପାଉଛି। ତେବେ ପାଣିପାଗ କେନ୍ଦ୍ରର ପୂର୍ବାନୁମାନ କହୁଛି, ମୌସୁମି ଦୁର୍ବଳ ରହିବା ସତ୍ତ୍ୱେ ଆସନ୍ତା ୧୪ ତାରିଖ ପର୍ଯ୍ୟନ୍ତ ରାଜ୍ୟର ବିଭିନ୍ନ ଜିଲାରେ ବିଜୁଳି ଘଡଘଡି ସହ ବର୍ଷାର ପରିମାଣ ବୃଦ୍ଧି ପାଇବ। ବୁଧ ଓ ଗୁରୁବାର ଅଧିକ ବଜ୍ରପାତ ସମ୍ଭାବନା ଥିବାବେଳେ ଶୁକ୍ର ଓ ଶନିବାର ଏହା ହ୍ରାସ ପାଇବ। ଆସନ୍ତା ୨୪ ଘଣ୍ଟା ମଧ୍ୟରେ ଉତ୍ତର ଓଡ଼ିଶାର କେତେକ ସ୍ଥାନ ଏବଂ ଦକ୍ଷିଣ ଓଡ଼ିଶାର ଅଳ୍ପ କେତେକ ସ୍ଥାନରେ ବିଜୁଳି ଘଡଘଡି ସହ ବର୍ଷା ହୋଇପାରେ। ବାଲେଶ୍ୱର, ଭଦ୍ରକ, ଯାଜପୁର, କେନ୍ଦ୍ରାପଡା, କଟକ, ଜଗତସିଂହପୁର, ପୁରୀ, ଖୋର୍ଦ୍ଧା, ନୟାଗଡ, ଗଞ୍ଜାମ, ଗଜପତି, କେନ୍ଦୁଝର, ମୟୂରଭଞ୍ଜ, ଅନୁଗୋଳ, ଢେଙ୍କାନାଳ, କନ୍ଧମାଳ ଏବଂ ରାୟଗଡା ଜିଲାର ଗୋଟିଏରୁ ଦୁଇଟି ସ୍ଥାନରେ ବଜ୍ରପାତ ଘଟିବାର ସମ୍ଭାବନା ରହିଛି।

ଖଜୁରିପଦା ହତ୍ୟା ଘଟଣାର ମୁଖ୍ୟ ଅଭିଯୁକ୍ତ ଗିରଫ

ବାଙ୍କୀ/ବୈଦ୍ୟେଶ୍ୱର, ୧୦ା୮ (ନି.ପ୍ର.): ବାଙ୍କୀ ବ୍ଲକ ଅନ୍ତର୍ଗତ ନୂଆଗାଁ ପଞ୍ଚାୟତ ଖଜୁରିପଦା ହତ୍ୟା ଘଟଣାରେ ମୁଖ୍ୟ ଅଭିଯୁକ୍ତ କୁହାଯାଉଥିବା ପାଣ୍ଡବ ପ୍ରଧାନଙ୍କୁ ମଙ୍ଗଳବାର ଚନ୍ଦକା ଅଞ୍ଚଳରୁ ଗିରଫ କରାଯାଇଛି। ୨୦୨୦ରେ ଏହି ହତ୍ୟାକାଣ୍ଡ ଘଟିଥିଲା। ନୂଆ ଗାଁ ସରପଞ୍ଚଙ୍କ ସ୍ୱାମୀ ଭଗବାନ ସ୍ୱାଇଁ ଓ ସାମ୍ବାଦିକ ଆଦିତ୍ୟ ରଣସିଂହଙ୍କୁ ହତ୍ୟା ଅଭିଯୋଗରେ ପାଣ୍ଡବ ପ୍ରଧାନଙ୍କ ସମେତ ୧୩ଜଣଙ୍କ ନାମରେ ମାମଲା ରୁଜୁ କରାଯାଇଥିଲା। ପୂର୍ବରୁ ୧୨ ଅଭିଯୁକ୍ତଙ୍କୁ ଗିରଫ କରାଯାଇଥିଲା। ସେହିଦିନଠାରୁ ପାଣ୍ଡବ ଫେରାର ଥିଲା। ସେ ଚନ୍ଦକା ଅଞ୍ଚଳରେ ଥିବା ଜଣାପଡ଼ିବା ପରେ ବାଙ୍କୀ ଉପଖଣ୍ଡ ପୁଲିସ ଅଧିକାରୀ ବାସୁଦେବ ସ୍ୱାଇଁ ଚଢ଼ଉ କରି ଏକ ଅଟ୍ଟାଳିକାରୁ ତାକୁ ଗିରଫ କରିଥିଲେ। ଅଭିଯୁକ୍ତକୁ ଅଦାଲତ ଚାଲାଣ କରାଯାଇଛି।

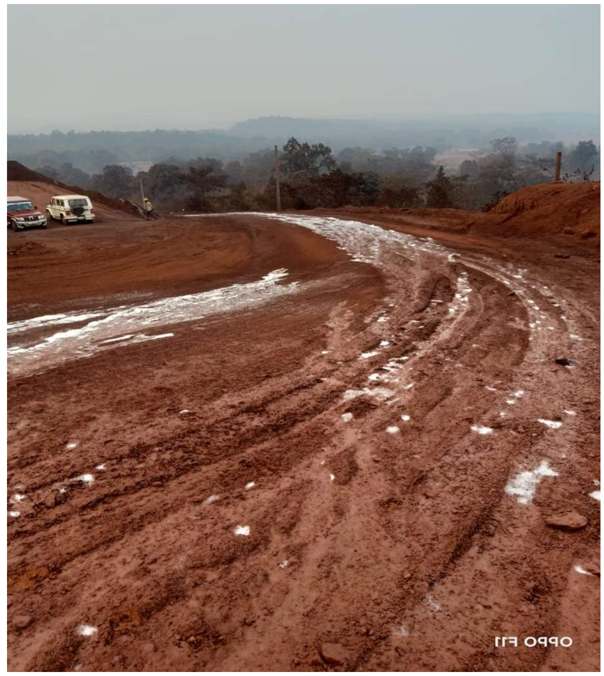
ବୈଷୟିକ ପରାମର୍ଶଦାତାଙ୍କ ୨.୦୪ କୋଟି ଠାବ

ଭୁବନେଶ୍ୱର,୧୦ା୮ (ନି.ପ୍ର): ଆୟ ବହିର୍ଭୂତ ସମ୍ପତ୍ତି ଠୁଳ ଅଭିଯୋଗରେ ମଙ୍ଗଳବାର ଯୋଡା ବ୍ଲକ ସମଗ୍ର ଶିକ୍ଷା ଅଭିଯାନର ବରିଷ୍ଠ ବୈଷୟିକ ପରାମର୍ଶଦାତା କ୍ଷେତ୍ରବାସୀ ମହନ୍ତଙ୍କ ବାସଭବନ ସମେତ ୪ଟି ସ୍ଥାନରେ ଦୁର୍ନୀତି ନିବାରଣ ବିଭାଗ ପକ୍ଷରୁ ଚଢ଼ଉ କରାଯାଇଛି। ଚଢ଼ଉ ବେଳେ ଶ୍ରୀ ମହନ୍ତଙ୍କର କେନ୍ଦୁଝର ପବିତ୍ରଡିହାରେ ଏକ ଦୁଇମହଲା କୋଠା ଓ କମରଗାଡିଆରେ ଗୋଟିଏ ବାସପଯୋଗୀ ଜମି ଥିବା ଜଣାପଡିଛି। ଏହାବ୍ୟତୀତ ତାଙ୍କର ଦୁଇଟି ବସ, ତିନୋଟି ଚାରିଚକିଆ ଯାନ, ଗୋଟିଏ ମୋଟରସାଇକଲ, ବିଭିନ୍ନ ବୀମା କମ୍ପାନୀରେ ୬୬ଲକ୍ଷ ଟଙ୍କାର ନିବେଶ ଏବଂ ବ୍ୟାଙ୍କରେ ୨.୪୨ଲକ୍ଷ ଟଙ୍କା ଜମା ଥିବା ଜଣାପଡିଛି। ଶ୍ରୀ ମହନ୍ତଙ୍କର ସମସ୍ତ ସ୍ଥାବର ଓ ଅସ୍ଥାବର ସମ୍ପତ୍ତିର ପରିମାଣ ୨.୦୪ କୋଟି ଟଙ୍କା ଆକଳନ କରାଯାଇଛି।


AAQMS 01 - Mines Office
PM10 38.25 ug/m3
PM2.5 19.75 ug/m3
CO 0.49 mg/m3
SO2 5.25 ug/m3
NOX ug/m3


PARAMETER
PM 2.5 - 42.3 ug/m3
(Standard - 60 ug/m3)


OPPO F11


OPPO F11

Member Secretary

केन्द्रीय भूमि जल प्राधिकरण
जल संसाधन, नदी विकास एवं
गंगा संरक्षण मंत्रालय
भारत सरकार

Central Ground Water Authority
Ministry of Water Resources
River Development & Ganga Rejuvenation
Government of India

CGWA/IND/Proj/2017-241-R

No.21-4(92)/SER/CGWA /2008- 1831

Dated:- 03 NOV 2017

To

M/s KJS Ahluwalia,
Nuagaon Iron Ore Mines
P.O. Barbil, District Keonjhar, Odisha

Sub:- Renewal of NOC for ground water withdrawal to Nuagaon Iron Ore Mines with beneficiation plant of M/s KJS Ahluwalia, located at Village Nuagaon & Guali, Block Joda, Taluk Barbil, District Keonjhar, Odisha - reg.

Refer to your application dated 27.04.2017 on the above cited subject. Based on recommendations of Regional Director, CGWB, South Eastern Region, Bhubaneswar vide their office letter No.5-22/SER/CGWA/2017-18-857 dated 11.08.2017, and further deliberations on the subject, the renewal of NOC issued vide this office letter of even no. dated 31.01.2014 is hereby accorded to **Nuagaon Iron Ore Mines with beneficiation plant of M/s KJS Ahluwalia, located at Village Nuagaon & Guali, Block Joda, Taluk Barbil, District Keonjhar, Odisha.** The renewal is however subject to the following conditions:-

1. The firm may abstract **1,225 m^3/day** of ground water **(not exceeding 4,47,125 m^3/year)** through existing seven (7) bore wells only. No additional ground water abstraction structures to be constructed for this purpose without prior approval of the CGWA.
2. All the wells to be fitted with water meter by the firm at its own cost and monitoring of ground water abstraction to be continued on regular basis at least once in a month. The firm will continue to provide data of ground water extraction on regular basis to the Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar. The ground water quality to be monitored twice in a year during pre monsoon and post monsoon periods.
3. **M/s KJS Ahluwalia, Nuagaon Iron Ore Mines,** shall, continue to implement ground water recharge measures to the tune of **4.6 million m^3/year** for augmenting the ground water resources in consultation with the Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar. Firm shall also undertake periodic maintenance of recharge structures at its own cost.
4. The firm shall continue to execute ground water regime monitoring programme by installing one more piezometer in addition to existing one piezometer. Both

West Block - 2, Wing - 3, Sector - 1, R.K. Puram, New Delhi - 110066
Tel : 011-26175362, 26175373, 26175379 Fax : 011-26175369
Website : www.cgwb.gov.in, www.mowr.gov.in

the piezometers should be fitted with automatic water level recorder having telemetry system within 90 days of the issuance of renewal of NOC in consultation with the Central Ground Water Board, South Eastern Region, Bhubaneswar.

5. The ground water monitoring data in respect of S. No. 2 & 4 to be submitted to Central Ground Water Board, South Eastern Region, Bhubaneswar on regular basis at least once in a year.
6. The firm shall ensure proper recycling and reuse of waste water after adequate treatment.
7. Action taken report in respect of S.N o. 1 to 6 may be submitted to CGWA within one year period.
8. The renewal is liable to be cancelled in case of non-compliance of any of the conditions as mentioned in S. No. 1 to 7.
9. This NOC is subject to prevailing Central/State Government rules/laws or Court orders related to construction of tubewell/ground water withdrawal/construction of recharge or conservation structures/discharge of effluents or any such matter as applicable.
10. This NOC does not absolve the applicant / proponent of his obligation / requirement to obtain other statutory and administrative clearances from other statutory and administrative authorities.
11. The NOC does not imply that other statutory / administrative clearances shall be granted to the project by the concerned authorities. Such authorities would consider the project on merits and be taking decisions independently of the NOC.
12. This renewal of NOC is valid for five years from date of issuance of this letter.

Member Secretary

Copy to:

1. The Member Secretary, Odisha Pollution Control Board Paribesh Bhawan, A/118, Nilakantha Nagar, Unit - VIII, Bhubaneswar, Odisha **with a request to ensure that the conditions mentioned in the NOC are compiled by the firm in consultation with the Collector & District Magistrate, District Keonjhar, Odisha.**
2. The District Collector and District Magistrate, District Keonjhar, Odisha for necessary action.
3. The Regional Director, Central Ground Water Board, South Eastern Region, Bhubaneswar. This has reference to your recommendation dated 11.08.2017.
4. TS to the Chairman, Central Ground Water Authority, Shram Shakti Bhawan, Rafi Marg, New Delhi.
5. Guard File 2017-18.

/

Member Secretary

Nitin Kumar <nitin.kumar2@jsw.in>

Fwd: [External Mail] Decision of 24th Internal EAC_21-4/92/OR/MIN/2017_M/s JSW Steel Ltd Nuagaon Iron Ore Mines

2 messages

Baswaraj Dalgade <baswaraj.dalgade@jsw.in> Wed, May 17, 2023 at 5:56 PM
To: Nitin Kumar <nitin.kumar2@jsw.in>, Suresh Mohapatra <suresh.mohapatra@jsw.in>

---------- Forwarded message ---------
From: **Central Ground Water Authority** <cgwa@nic.in>
Date: Wed, 17 May, 2023, 5:32 pm
Subject: [External Mail] Decision of 24th Internal EAC_21-4/92/OR/MIN/2017_M/s JSW Steel Ltd Nuagaon Iron Ore Mines
To: <baswaraj.dalgade@jsw.in>

Sir
You are here with requested to find the below decision for the above mentioned application.
Internal EAC committee is considered opinion that the project is **APPROVED**.

Regards,

O/o सदस्य सचिव Member Secretary,
केंद्रीय भूजल प्राधिकरण Central Ground Water Authority
जल शक्ति मंत्रालय, भारत सरकार Ministry of Jal Shakti, Govt. of India
18/11, जामनगर हाउस, मानसिंह रोड, नई दिल्ली-110011
18/11, Jamnagar House, Mansingh Road, New Delhi-110011
Ph- (011) 23383824; Fax- (011) 23382051; e-mail: cgwa@nic.in

Nitin Kumar <nitin.kumar2@jsw.in> Wed, May 17, 2023 at 6:04 PM
To: Baswaraj Dalgade <baswaraj.dalgade@jsw.in>

Thank You sir.
[Quoted text hidden]

NARAYANPOSHI IRON AND MANGANESE ORE MINES
From Dec 2020 to april 2022

DateTime	WATER LEVEL (mWC)
12/1/2020 9:00	-13.55
12/1/2020 21:00	-13.45
12/2/2020 9:00	-13.55
12/2/2020 21:00	-13.45
12/3/2020 9:00	-13.55
12/3/2020 21:00	-13.45
12/4/2020 9:00	-13.55
12/4/2020 21:00	-13.45
12/5/2020 9:00	-13.56
12/5/2020 21:00	-13.46
12/6/2020 9:00	-13.56
12/6/2020 21:00	-13.46
12/7/2020 9:00	-13.56
12/7/2020 21:00	-13.46
12/8/2020 9:00	-13.56
12/8/2020 21:00	-13.46
12/9/2020 9:00	-13.57
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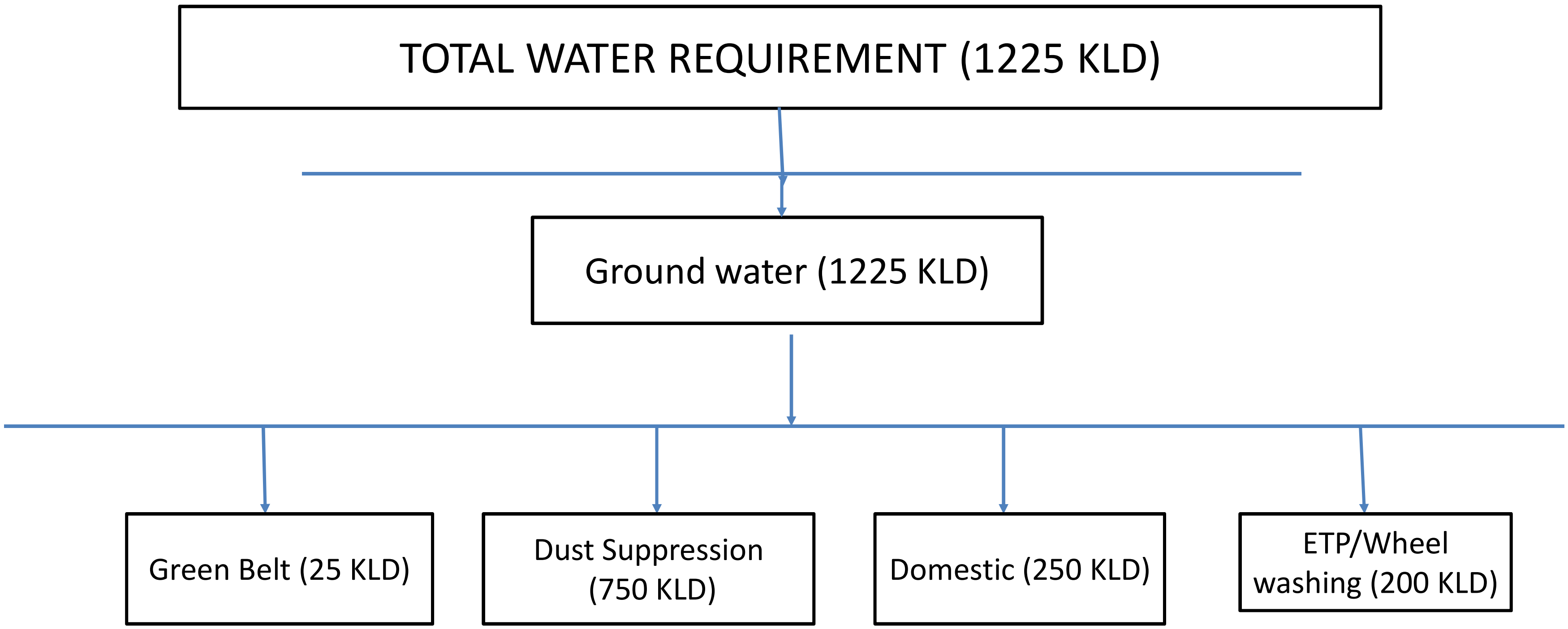
NUAGAON IRON ORE MINES



Investigation

On

Slope Stability Study – JSW Nuagaon Iron Ore Mines

Work order no. Odisha Mines/118402/SER/4500141067 **date.** 16-04-2022

(Source: https://earth.google.com/web)

Dept. of Mining Engineering

National Institute of Technology, Rourkela

March 2023

1.0 Introduction

Surface mining operation is major and popular process to excavate earth materials. Though this approach is relatively simple and fast, yet it often endangers the men and machines, and thus its economics, unless scientifically planned. Bench mining or slope system is a major part of the surface excavation system. Correct slope design and its stability has been a major challenge to mine operation. The slope design involves knowledge of geotechnical parameters, geological influences, correct slope height, slope angle and overall angle. Government regulation also warrants carrying out slope design as a part of statutory requirement.

1.1 Brief Description of the Project

NIT Rourkela received a work order vide purchase order no Odisha Mines/118402/SER/4500141067 dated 16-04-2022 from JSW Steel Ltd., Barbil, Odisha for scientific study of the stability of pit slope and dump slope in iron ore mines in Odisha. This is an assignment that originated in 01-09-2020 from JSW Steel, Delhi. NIT Rourkela accepted the order on 2nd June, 2022 and initiated investigation. As a part of the investigation, the team initiated the investigation in June-2022 and made many visits to the mine. It discussed with mine officials, inspected the area, carried out geological study, identified a few sample location of the iron ore deposit at the Nuagaon Iron Ore region.

1.2 Scope of work

The aim of the investigation was to carry out scientific study of the stability of pit slope and dump slope in iron ore mines in Odisha, JSW Steel Ltd., Barbil, Odisha. The scope of work as outlined in the work order was.

i. To undertake the study of slope stability to arrive ultimate pit slope and dump slope for long term safety.

ii. Suggest methods for dump slope monitoring.

iii. Suggest best practices for slope maintenance and its stabilization.

iv. Optimization of dump slope parameters for capacity maximization.

v. Recommendation for following, considering geotechnical characteristics of deposit:

   a) Slope angle for working and final pit
   b) Dump design parameters (Dump height and slope; bench height and slope angle)
   c) Monitoring method of PIT and dump slope stability

1.2.1 Background of the problem

The concerned mine belonging to JSW Steel Limited is a Category – A (fully mechanized category) mine and is worked by opencast mining method with formation of benches by drilling and blasting. It results in higher rates of recovery from the mine with an increased percentage of iron ore recovery, thereby improving productivity and sales. The analysis investigation of the prevalent geo-mining conditions of the mine, collection of pertinent geotechnical data, and their influence. Thereafter, a suitable rock mass classification system was adopted to classify the rock based on its physical properties followed by reducing the strengths of the material cover present at the site by their visible characteristics following scientific approaches and lastly, numerical modelling was adopted to simulate the models of failure in determining safety factors.

2.0 Geology

2.1 Regional Geology

Nuagaon Iron Ore Mine lies over the Upper Shale Formation of the Koira Group as described by Murthy & Acharya (1975). Litho units like Iron ores of HLO, SLO, lateralized HLO types, Fe-Shale, laterites of both aluminous and ferruginous nature, float ores concealed under soil and alluvial cover at places are mapped in the Nuagaon Iron Ore Mine. The lease area is characterized by hilly as well as flat ground having elevation from 520m to 702m above M.S.L. The hills and hill ranges located within the lease area are Udalbari, Guali, Topadihi, Dumkahudi, Barpada, Kanhusahi & Bichhagarh-Katasahi. The M.L. area discerns a fairly wide range of rock types of the iron ore group. The area has a geomorphic trend of North-North-East to South-South-West which is almost conformable with the strike trend of the rock types. The different rock types observed in field from the exposures and mine working areas are as follows:

<table>
<tr><th>Litho units</th><th colspan="2">Disposition of various litho units</th></tr>
<tr><td>Soil & alluvium</td><td colspan="2">Soil thickness of 1 to 1.5m occurs in the western part and along both side of NH-520.</td></tr>
<tr><td>Laterite</td><td colspan="2">Most part of the area is covered by laterite of various types. The laterites have been developed mostly over the shale unit of the area and depending upon the composition of the shale, different types of laterites have been developed. The shale rich in alumina has given rise to aluminous laterite and those rich in iron developed into ferruginous laterites. Ferruginous laterite occurs as capping in the southern, central, northern and western part of the lease area. The thickness of laterite is about 7-10m and depends upon topography of the hills.</td></tr>
<tr><td>Lateritic Iron ore</td><td colspan="2">As per bore hole data and exposed quarries top benches of quarries are found with lateritic iron ore. The thickness of lateritic ore varies from 10m to 15m.</td></tr>
<tr><td>Upper Shale Formation</td><td colspan="2">Ferruginous Shale Unit: Shales of different color like pink, yellow, variegated with inter beds of Iron ore occurs within Chhenaguda quarry, Gangeiguda quarry etc. The colouration of the shale is largely dependent on the mineral composition (Murthy & Acharya, 1975). It is mostly composed of clayey micaceous minerals, with lenses of chert. Most of the area containing this unit is lateralised extensively.</td></tr>
<tr><td>Banded Iron Formation</td><td>HLO
SLO
Blue dust</td><td>Based on surface exposures and sub-surface geology 4 (four) types of iron ore have been recorded in the lease area. These are Hard Laminated Ore (HLO), lateralized HLO, Soft laminated Ore (SLO) and powdery ore (blue dust, reddish brown powdery ore).
The HLO is exposed on the benches of mostly top of the Chennaguda quarry, B-top, B-bottom, Gangeiguda quarry, Sonukocha quarry.
The length of individual HLO varies from quarry to quarry. Strike of the HLO mostly matching with the regional strike i.e. NE-SW
The lateralized HLO exposed on the NE part of Gangeiguda quarry as well as B-top, B-bottom.The SLO due to its soft nature are not exposed on the surface. In all the quarries when we go down SLO and blue dust/powdery orecan be found.</td></tr>
<tr><td>Lower shale</td><td colspan="2">Lower shale occurs within western and south western part of Katasahi quarry and North eastern part of MDH quarry.</td></tr>
<tr><td>BHJ/BHQ</td><td colspan="2">BHJ comprises alternate bands (laminations less than 5mm thick) of hematite and dark brown to red jasper. BHJ have been intersected nearer to the bottom portion of the boreholes. BHJ/BHQ occurs within southern part of Chhenaguda quarry, and Guali quarry.</td></tr>
</table>

2.2 Structural Features

In general, the Iron Ore Super Group represented by the Bonai-Kendujhar belt in Koira basin is disposed in the form of an "Omega" and referred to as "Horse shoe synclinorium" (Jones, 1934). This belt is 60 km long and 25 km wide extending from south of Malangtoli in Kendujhar district up to Chakradharpur in West Singhbhum district (Jharkhand). The structural fabrics in the above, feebly metamorphosed volcano-sedimentary litho-sequence indicate at least two phases of deformation and folding. The earlier phase is the most prominent and resulted in formation of two synclines intervened by an anticline trending NNE-SSW with a low north-north easterly plunge. The western limb is slightly overturned to the east and dip westerly (65^0-75^0) whereas, the eastern limb is a normal one with moderate to low (30^0-45^0) westerly dip. This phase of folding is affected by a later NW-SE to WNW-ESE trending fold axis resulting in broad warps and formation of structural domes and basins in the area. The western syncline known as Koira syncline, due to steep dip and overturned nature of its limb forms a deeper basin with thick sequence of younger shale in the core region.

3.0 Mining Methodology

The mine is operated by the opencast fully mechanized method. There are 4 major well-developed mechanized quarries as Sonu Kocha, MDH, Chenagoda and Kahnusahi. In all quarries, bench height is maintained up to 10 m and width up to 18 - 21 m, adhering to the MMR-2016 guidelines. During the proposed period of mining operation, excavation for iron ore is done in four of the quarries. Production capacity per annum of the mine is envisaged as 7.99 million tons per year from the in-situ reserve. The Mineable reserves are 622.51 MT. MMR-1961 is adopted for regulatory and excavation activities.

Drilling was carried out using 115mm diameter drills with 10% subgrade drilling to avoid toe formation. Blasting was by SME (Site Mixed Emulsion) explosives manufactured and supplied by Solar Industries India Ltd., Nagpur, Maharashtra. Its VOD and final density are 4000±500 m/sec, and 1.15±0.005 g/cc respectively. The mines used 17 and 25 milliseconds for the Trunk-Line-Delay, and 250 milliseconds for the Down-The-Hole delay. The burden for blast hole pattern varied between 2.5 to 3.5 and spacing from 3 to 3.5. Series pattern was adopted to reduce the maximum charge per delay. Controlled blasting along with a shock tube initiation system/NONEL system was practiced to get optimum blast results and minimize hazards. In addition, rock breakers are used to reduce the size of undesirable boulders produced during blasting. The design parameters of the mine are in table 1.

Table1. Design Features

Sl. No.	Salient Feature	Description
1	Method of Mining	Fully mechanized
2	Production	7.99 Mt/yr Iron ore (ROM)
3	Means of Raising	Drilling, blasting, excavation, processing, etc
4	Bench Height	upto 10 m
5	Bench Width	18-21 m
6	Bench Angle	85^0
7	Overall Slope	33^0
8	Transportation of ore to the stacking yard	Through dumpers and tippers
9	Blasting Proposal	Deep hole blasting is carried out to dislodge the boulders

1.5 Safety Factor Analysis

The stability of rock slopes depend on behaviour of the shear strength created along the sliding surfaces. In general rock or rock material, is assumed to follow the Mohr Coulomb criteria and the strength is expressed in terms of cohesion 'c' and friction angle $'\emptyset'$and is expressed mathematically as $\tau = c + \sigma' tan\emptyset$ [τ = shear strength, c = cohesion, σ' = effective normal stress, and $\emptyset$ = friction angle]

The effective normal stress is the difference between the stress due to the weight of the rock lying above the sliding plane and the uplift due to any water pressure acting on this surface.

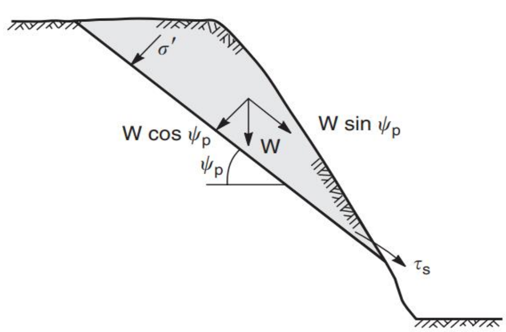


Figure II. Slope Block Analysis[12]

The stability of the block can be quantified by the ratio of the resisting and driving forces, which is termed the factor of safety (FOS). And is given by

$$FOS = \frac{\text{Resisting Forces}}{\text{Driving Forces}}, or$$

$$FOS = \frac{cA + W \cos \psi_p \tan \emptyset}{W \sin \psi_p}$$

The resisting strength is more than the displacing stress for stability of the slope.. The FOS equation at equilibrium is

$FOS = \frac{\cos \psi_p \ \tan \emptyset}{\sin \psi_p}$ or, $FOS = 1$ When $\psi_p = \emptyset$

It shows that when there are no in-filling materials, the block of rock will slide when the dip angle of the sliding surface equals the friction angle of this surface, and the stability is independent of the size of the sliding block. The block is at a condition of "limiting equilibrium" when the driving forces are exactly equal to the resisting forces and the factor of safety is equal to 1.0. Therefore, the method of slope stability analysis is termed limit equilibrium analysis. For the investigation of stability of the existing slopes, the minimum factor of safety is from 1.3 to 1.5 [3]

The Limit Equilibrium Method (LEM) is a well-known computational methodology for evaluating the Factor of Safety (FOS) and stability degree of slopes (Duncan, 1996, Krahn 2003). Limit equilibrium is the method where limit state conditions are assumed. The limited equilibrium methods (LEMs) are popular to assess the slope stability of mine geological sections.

In this slope stability investigation project, a dedicated software for LEM code Slide2D (RocScience Inc., Canada) used. Slide 2 is a two-dimensional limit equilibrium slope stability analysis program for evaluating the probability of failure of geological transverse and geological sections by identifying circular or non-circular failure-prone surfaces in soil or rock slopes. It analyzes the stability of slip surfaces using vertical slice or non-vertical slice limit equilibrium methods. This code has extensive probabilistic analysis capabilities that can be utilized to assign statistical distributions to almost any input parameters, including material properties, support properties, loads, and water table location. The probability of failure/reliability index is determined, providing a measure of the risk factor associated with a slope design.

The evaluation needs geotechnical data that were obtained from laboratory testing through the samples supplied.

1.6 Geotechnical Investigation

For a planned excavation or for an engineered earth-system design, the most important consideration is the reaction of the rocks to the changes in stresses due to the proposed excavation provided that the resultant strain is within the tolerable limit of the engineering design. Typically, the behavior of rocks is determined from unbroken rock pieces, i.e., intact rock or rock core through rocks are heterogenous, anisotropic and inelastic. The geotechnical investigation of core specimen includes the laboratory determination of the pertinent parameters.

1.6.1 Location of sample collection points

Slope stability analysis involves understanding and dealing with the behavior of earth materials at specific locations e.g. face, bench, strata, etc. The behavior of materials are scientifically represented by its geotechnical properties as cohesion, density, angle of internal friction, compressive strength, etc. it needs sample collection and testing by established processes.

The locations of samples were collected were carefully chosen depending upon site characteristics. It was made sure that the samples were collected from the bench faces. Fresh samples were collected freshly exposed as so after blasting. The information from the result of any test depends on the health of the sample or specimen tested for the purpose. In this investigation samples for various parameters have been prepared from the samples collected. In absence of regular core logs, boulders of adequate sizes of about 900cm^3 each were collected and transported to the laboratory. NX core samples were prepared from those boulders. Soft material as alluvium, laterite and ochre were collected in air tight bags and processed for shear testing. The following sections discuss the procedure adopted for testing. The test specimens were obtained by cutting the core samples perpendicular to the cylindrical axis with the help of a rock cutting machine fitted (make: AIM 202, AIMIL, India). The length to diameter ratio was kept between 2.0 to 2.5 for the samples for determination of Compressive Strength and at 0.5 for tensile Strength. The loading surfaces of the test specimen were made flat within ± 0.01mm.The following photographs are provided below.

Figure III. Sample collection

1.6.2 Testing Procedures:

The determination of different physical and mechanical properties were carried out by IS guidelines as mentioned against each type of test and described below.

a. Density	IS: 13030-1991 (Reaffirmed 1996)
b. Compressive Strength	IS: 9143-1979 (Reaffirmed 1996)
c. Triaxial Strength	IS: 13047-1991 (Reaffirmed 2001)
d. Shear Strength	IS: 2720-part13-1986 (Reaffirmed 2002)

Figure IV. Coring operation and cored specimen

1.6.2.1 Density

Density reflects the information about the mineralogical or grain constituents. For determination of density Indian Standard 13030:1991 has been followed. Each specimen was machined to conform closely to the geometry of a right cylinder. The mass of each specimen was typically more than 600g. Each sample was put in an oven maintained at a temperature of $105^0 \pm 3^0C$ for 24 hours. The samples were removed from the oven after 24 hrs and placed in desiccators for cooling. Each sample was brushed to remove loose material sticking to it. The external dimension of each specimen was determined using a digital caliper (make: Mitutoyo, Japan) with an accuracy of 0.01mm. Average of three readings each for the length and diameter were taken for calculation of volume (V). The mass (M) of each specimen was determined using a digital balance (make: Contech, India) with an accuracy of 0.001g. The density (ρ) was determined using the formula $\rho = {M}/{V}$ where M and V are Mass and volume of the sample respectively.

1.6.2.2 Uniaxial Compressive Strength

In most of the engineering design the compressive strength (UCS) of rock is one of the most important input parameter. It reflects the ultimate bearing capacity before the rock fails i.e. the total loss of integrity in the sample. The compressive strength of the test specimen was determined following IS:9143-1979. The selected specimen of length to diameter ratio between 2 to 2.5 was wiped clean and the dimensions were measured with the help a digital caliper. The measurement of diameter was carried out by taking the average of four reading obtained at about upper height, two mid-heights and lower height. The cross-sectional area was calculated from this measurement.

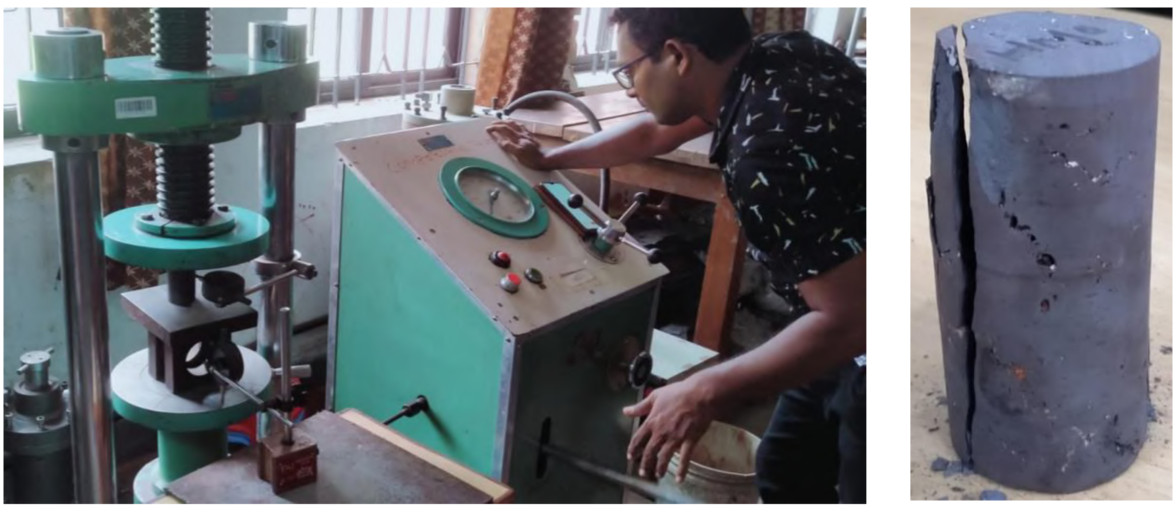


Figure V. Determining UCS of rock sample

The surfaces of the two bearing discs and the test specimen were wiped clean. The specimen was placed between the two platens. The upper disc was then gradually lowered onto the specimen. Care was taken to see that the axis of the specimen was properly aligned with the discs. The loading machine was operated at a stress level, typically between 0.5 to 1 MPa/sec so that the sample fails within 8 to 12 minutes of test. Load was then continuously applied at a constant rate till failure occurred and the maximum load on the specimen was recorded. The compressive strength is determined from the relation as given by the equation $\sigma_c = \frac{F}{A}$ where σ_c is UCS; F is Failure load; and A is the cross sectional area of the sample

1.6.2.3 Triaxial Compression Test

Rock exhibits higher bearing capacity when the same is confined. The failure load varies with confinement pressure. Triaxial compression refers to a test with simultaneous compression of a rock sample and application of axisymmetric confining pressure. The triaxial Compressive Strength of rock samples was determined following IS 13047:1991. The result shows the cohesion and friction angle. The test sample was wiped clean and its diameter was measured at upper, two-mid and lower heights respectively. The average value was used to calculate the cross sectional area of the test sample. The sample was then put in the triaxial cell (make: AIMIL, India).

Fig VI: Triaxial Setup and Fractured Sample

The specimen, the platens and the spherical seat were accurately aligned to ensure that they are coaxial with others. The cell was then filled up with hydraulic oil, allowing the air to escape through an air bleeder valve. The air bleeder valve was then closed. The cell was then placed into the axial loading device. The axial load and the confining pressure were increased simultaneously in such a way that axial stress and confining pressure were approximately equal and until the predetermined test level for the confining pressure reached. The axial load was then increased continuously without shock to produce an approximately constant rate of load for deformation. The maximum axial load and the corresponding confining pressure were recorded. Then the confining pressure and corresponding longitudinal failure strength were plotted in the same scale to plot Mohr analysis for the determination of cohesion and angle of internal friction. The lateral confinement was provided between 0.0 and 3.92 MPa.

1.6.2.4 Shear Strength Test

The top layers of the strata consist of different varieties of soil as yellow, yellow loamy, brown, of varying grain sizes, etc. The parameters that would govern its engineering behaviour are cohesion and the angle of internal friction apart from the unit weight. Those are typically determined from the direct shear strength test. The test involves applying horizontal load on the soil specimen so as to undergo sharing with a constant the vertical normal load. The relationship between normal stress and shear stress at failure provide the shear strength parameters (cohesion and internal friction angle). The specimen and testing of shear strength parameters was carried out as per IS:2720 (Part # 13, 1986 (Reaffirmed 2002)).

Fig VII: Direct Shear test

The joint in rock cores didn't exhibit any regular pattern, thickness, and presence. Hence the shear strength tests of the rock cores have not been performed to know the characteristics of joint filling material.

1.6.2.5 Test Results:

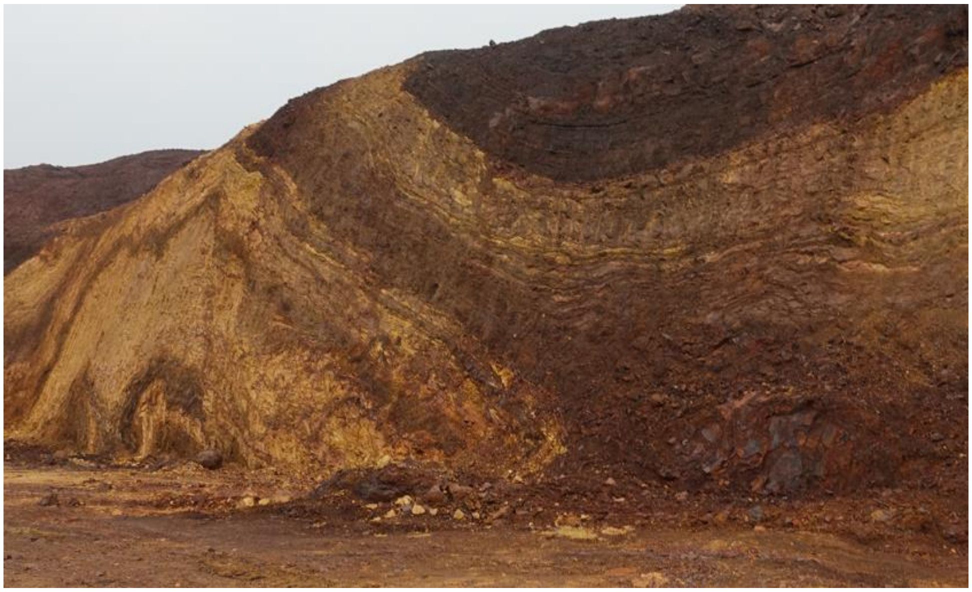
The results of the different tests carried out on the rock cores are reported in following pages. Density values represent the average values of the particular rock type. The photographs of testing arrangement, some typical failure profiles obtained during the testing have been given in figures below for the rock in compression, tensile, shear, and triaxial testing.

1.6.3 Rock Mass Classification

Cylindrical rock cores or samples of intact rocks are tested in the laboratory to determine their properties. However, such experimentations only reveal the strength of the intact rock masses and the data exhibited in the field often do not confirm to that in the laboratory tests. This is mainly due to the presence of discontinuities that causes instability to the rocks in the form of planes of weaknesses. One such approach by which the strengths of the rocks are reduced by visibly observing the discontinuities present in them is the Geological Strength Index (GSI), wherein the strength parameters of the rocks are considerably reduced to confirm to that of the rock masses exhibited in the field.

1.6.4 GEOLOGICAL STRENGTH INDEX (GSI)

A new rock mass classification scheme was introduced by Hoek and Brown (1997) based on visual observations of geological conditions making it simple, fast and reliable. It is called the Geological Strength Index (GSI). It reflects the property of a discontinuous or jointed rock mass which influences its strength and deformability. GSI considers the shapes of contact rock pieces as represented by its boundaries and degree of interlocking as well as the conditions on the surface separating those. The surface conditions vary from very good to very poor with GSI values between 100 and 0 respectively. The interlocking blocks vary between intact or massive to laminated or sheared.



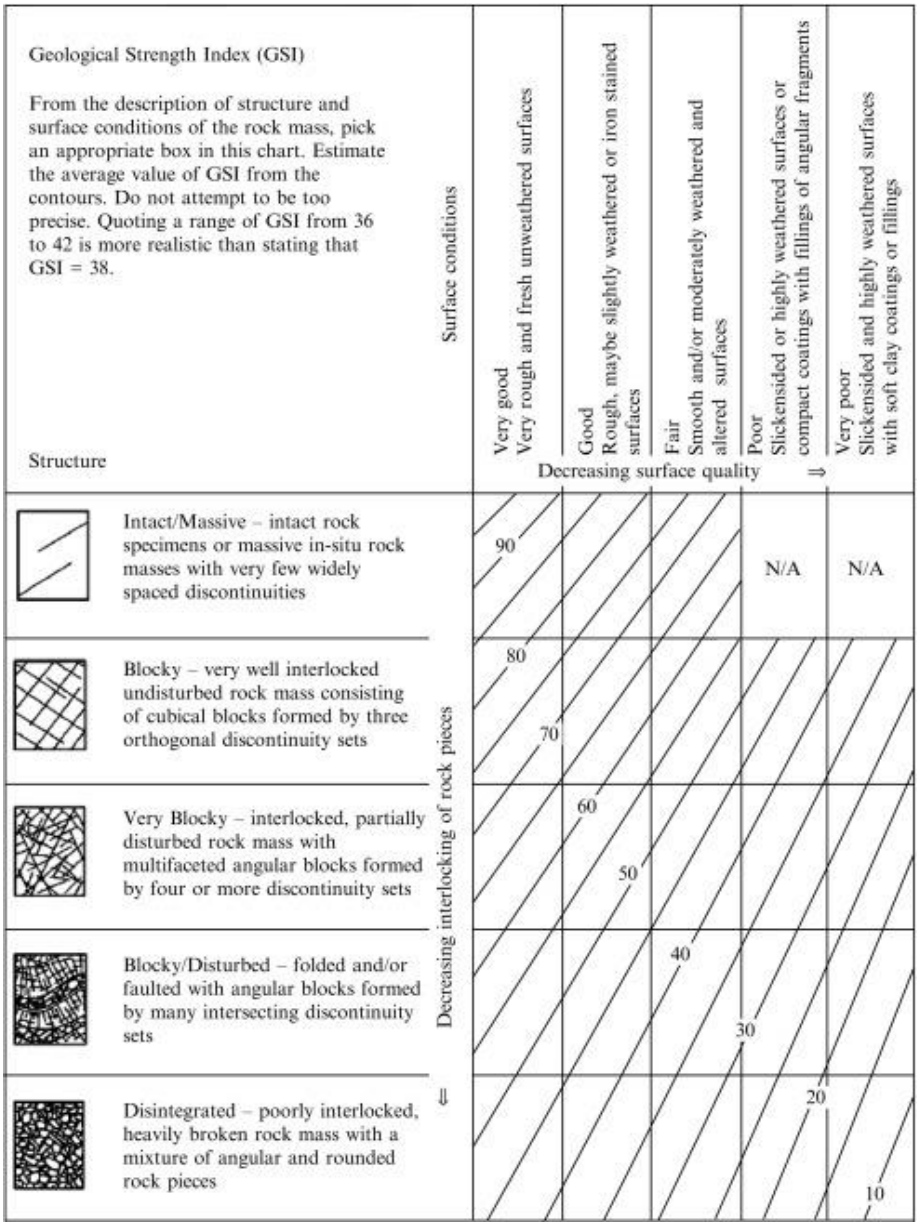


Fig. VI: The Geological Strength Index (GSI) chart used for rock mass

1.7 Slope Design, Modelling and Boundary Conditions

The shear strength of the rock mass including that of the joints and discontinuities typically influence stability of slopes. The determination of the rock behavior subjected to deformation including that of the joint and joint filling materials is a complex phenomenon. Hence, those are determined indirectly involving both laboratory data and test data. A number of such approaches exist for the determination of slope stability, however, intact rock criteria, Mohr-Coulomb (MC) and Hoek-Brown are the most popular approaches that are evaluated here. MC considers a linear relationship between shear strength and gravitational loading whereas HB considers a non-linear relationship. A few of those approaches for slope design are discussed below are used to find the shear strength as cohesion ‘c’ and angle of internal friction ‘φ’.

I. Mohr-Coulomb Approach:

It used the intact rock strength parameters i.e., cohesion and friction angle to find the factor of safety. It overestimates the rock mass strength or behavior in field conditions.

II. Generalized Hoek-Brown Approach:

It considers rock mass parameters like mineralogy, composition, grain size influence, degree of fracture, site influence, disturbance expected due to blasting and stress relief as well as visual observation data. The following are some of the empirical equations used to predict the rock mass parameters:

$$m_b = m_i \exp\left(\frac{GSI - 100}{28 - 14D}\right)$$

$$s = \exp\left(\frac{GSI - 100}{9 - 3D}\right)$$

$$a = \frac{1}{2} + \frac{1}{6}\left(e^{-\frac{GSI}{15}} - e^{-\frac{20}{3}}\right)$$

$$\sigma_{cm} = \frac{2c' cos\varphi'}{1 - sin\varphi'}$$

$$\sigma_{tm} = \frac{2c' cos\varphi'}{1 + sin\varphi'}$$

$$\sigma_{tm} = -\frac{s.\sigma_{ci}}{m_m}$$

Where, σ_{cm}, σ_{tm}, σ_{ci}, *c’* and *φ’* are uniaxial compressive strength of rock mass, tensile strength of rock mass, uniaxial compressive strength of intact rock, cohesion and angle of internal friction of rock mass respectively. The other parameter *D* is a factor for near surface blast damage and stress reduction, m_m, and $m_i$are Hoek and Brown parameter for rock mass and intact rock respectively depending on mineralogy, composition and grain size influence, *s* is a rock mass characteristic, i.e., how fractured the rock mass is with typical values in the range of 0.001 to 1 and *a* is a site constant for quality of rock, about 0.5. in this investigation. The surface mine would require blasting for excavation process. Therefore the value of *D* is considered to be 1 for such conditions where production blasting is carried out, and 0.7 where the rock mass can be extracted by mechanical excavations. The compressive and tensile strength values exhibited at the field are much less than that obtained in the laboratory testing. The effective uniaxial compressive strength value of the rock mass is determined from the empirical equation proposed by Marinos and Hoek (2001) as below:

$$\sigma_{cm} = 0.0034 m_i^{0.8} \sigma_{ci} (1.029 + 0.025 e^{-0.1 m_i})^{GSI}$$

III. Mohr-Coulomb Rock Mass Parameter Approach:

Mohr-Coulomb approach is quite popular and the various rock mass parameters such as cohesion, c' and angle of internal friction, φ' have been developed from the Hoek-Brown approach using the following relations (Hoek et al, 2002).

$$sin\varphi' = \frac{6am_m(s + m_m\sigma'_{3n})^{a-1}}{2(1+a)(2+a) + 6am_m(s + m_m\sigma'_{3n})^{a-1}}$$

$$\frac{c'}{\sigma_{ci}} = \frac{[(1+2a)s + (1-a)m_m\sigma'_{3n}](s + m_m\sigma'_{3n})^{a-1}}{(1+a)(2+a)\sqrt{\frac{1 + \left(6am_m\left(s + m_m{\sigma'_{3n}}^{a-1}\right)\right)}{(1+a)(2+a)}}}$$

$$\sigma'_{3n} = \sigma'_{3,\max}/\sigma'_{ci}$$

Where, $\sigma'_{3,\max}$ is maximum value of lateral stress. It is related to slope height H and unit weight γ of the rocks. The effective maximum lateral stress of the rock is given by the relation as below:

$$\frac{\sigma'_{3,\max}}{\sigma'_{cm}} = 0.72\left(\frac{\sigma'_{cm}}{\gamma H}\right)^{-0.91}$$

The design has considered the average values of the geotechnical parameters as determined from various approaches each with respective factor of safety with the application of gravitational force on the models created for analysis. The failure plane has been analyzed for wide variations in its locations and safety factors associated with the most critical plane is determined.

1.8 Failure consideration of the Ore Body slope

Slope failures in surface operations involving hard rocks primarily depend on the characteristics of the rocks and the behavior of the geological features as well as the interaction between the geology and the rock characteristics. Soil or heavily fractured earth materials typically fail by circular failure whereas rock geometry fails by circular failures if there is any intrusion of weak layers incorporated into the rock mass or typically rock geometry fails by plane, wedge or toppling modes. The stability of the slope is generally controlled by the shear strength parameters along with others. Stability analysis typically follows the limit equilibrium method. In limit equilibrium method, failure or sliding occurs when a limit equilibrium condition is reached i.e., when the resisting forces balance the driving forces such that any disturbances in the balance between them causes the slope to undergo failure. These design methods are widely accepted and are also commonly used and enable moderation of the slope performances with the variations in the parameters involved in slope design. The primary idea behind the limit equilibrium approach is to determine a state of stress along the surface which is likely to fail such that the free body, along with the slip surface and the free ground surface remains in static equilibrium. The state of stress is then compared with the available strength, which is the stress required to cause failure along the slip surface.

Thus, the analysis involves determination of the factor of safety against sliding for an unstable block of rock mass, represented by, FOS = F_r / F_s, where F_r is the total resisting force available against sliding and F_s is the driving force that induces the sliding. The analysis involves developing the model, assigning rock properties, specifying the boundary conditions followed by analyzing the whole of slope geometry to determine the location that would exhibit the lowest factor of safety.

1.8 Metal Mines Regulations, 2019(reproduced verbatim)

The Metal Mines Regulations (MMR) as prescribed by the Directorate General of Mines Safety (DGMS) lays the following guidelines in Section 116 and 118 in accordance to the stability of slopes those are reproduced verbatim below.

116. Mechanised Opencast working:

(1) The height of the benches in overburden consisting of alluvium soil, morum, gravel, clay, debris, soft ore body or other similar ground shall not exceed three meters and the width thereof shall not be less than three times the height of the bench or three times the width of the dumper if dumpers ply on the bench or as determined by the scientific study, whichever is more.

(2) The height of the benches in hard and compact ore body and overburden of rock formation other than that mentioned in sub-regulation (4) shall not be more than the digging height or reach of the excavation machine in use for digging, excavation or removal, and the width thereof shall not be less than -

(a) The width of the widest machine plying on the bench plus two meters; or

(b) If dumpers ply on the bench, three times the width of the dumper; or

(c) The height of the bench; or

(d) As determined by the scientific study whichever is more.

118. Spoil-banks and dumps.

(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) The slope of a spoil bank shall be determined by the natural angle of repose of the material being deposited but, in any case, shall not exceed 37.5 degrees from the horizontal or an angle in excess of natural angle of repose or as determined by the scientific study, whichever is less and such spoil bank shall not be retained by artificial means: Provided that where in any mine, a steeper slope of a spoil bank in excess of 37.5 degrees or natural angle of repose has been recommended as a result of a scientific study by any scientific agency or institution, having expertise in slope stability, the Regional Inspector may, by an order in writing and subject to such conditions as he may specify therein, permit a steeper slope of the spoil bank.

(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: Provided that, the Regional Inspector may, by an order in writing and subject to such conditions as he may specify therein, restrict height and overall slope of the spoil bank.

(5) The toe of a spoil bank shall not extend to any point within a distance equal to height of the spoil bank from a mine opening, railway or other public works, public road or other permanent structure not belonging to the owner: Provided that, the Regional Inspector may, by an order in writing and subject to such conditions as he may specify therein, may increase the distance in variance of the above.

1.8.2 Safety Analysis of Slope Profiles

The geological transverse sections for Nuagaon provided by JSW Steel Limited have been considered and those slope profiles were analysed. Each material present have been assigned suitable strength characteristics as obtained from laboratory testing and field observations and the factor of critical safety value is computed. A number of such sections have been analysed that are represented below. Ground water table is present well below the slope forming materials and hence is assumed to have no effect on the stability of the slopes that have been considered for stability analysis.

For Rock samples, the cores were used to determine its representative UCS values and for the loose rock mass the samples, their cohesion and internal friction were calculated by direct shear test. However these values are much higher and it’s not a reliable demonstration of the field condition. Therefore the GSI value is incorporated in the determination of cohesion and friction angle which is a much better representation of the field situation. Here, The GSI values were obtained from the on-site survey of the undisturbed exposed mineral outcrop. The m_i values were determined from the predefined values which best represents the rock strength. The Disturbance factor is considered 1 or 0.7 as per the mine practice.

Table 1 Geotechnical parameters of rock samples

ORE TYPE	GSI	UCS (MPa)	MC Rock Mass Parameters		HB Rock Mass Parameters		Average Density (g/cc
			Cohesion (MPa)	Friction Angle (Degree)	Cohesion (MPa)	Friction Angle (Degree)	
BHJ/BHQ	65	180	1.080	63	0.89	68	2.8
Lateritic Ore	55	35	0.131	53	0.079	67	1.83
Hard Laminated Ore	75	85	1.256	61	1.02	68	4.89

Table 2 Dry Rock Mass parameters

ORE TYPE	GSI	MC Rock Mass Parameters		Average Density (g/cc)
		Drained		
		Cohesion (MPa)	Friction Angle (Degree)	
SLO	46	0.07	39	3.26
Laterite	40	0.032	39	2.74
Blue Dust	39	0.03	28	2.95
Shale	60	0.017	35	1.87

Table 3 Saturated Rock Mass parameters

ORE TYPE	GSI	MC Rock Mass Parameters		Average Density (g/cc)
		Undrained		
		Cohesion (MPa)	Friction Angle (Degree)	
SLO	46	0.041	30	2.97
Laterite	40	0.027	39	2.47
Blue Dust	39	0.028	26	2.634
Shale	60	0.014	32	1.66

CHENAGODA QUARRY

N2430200

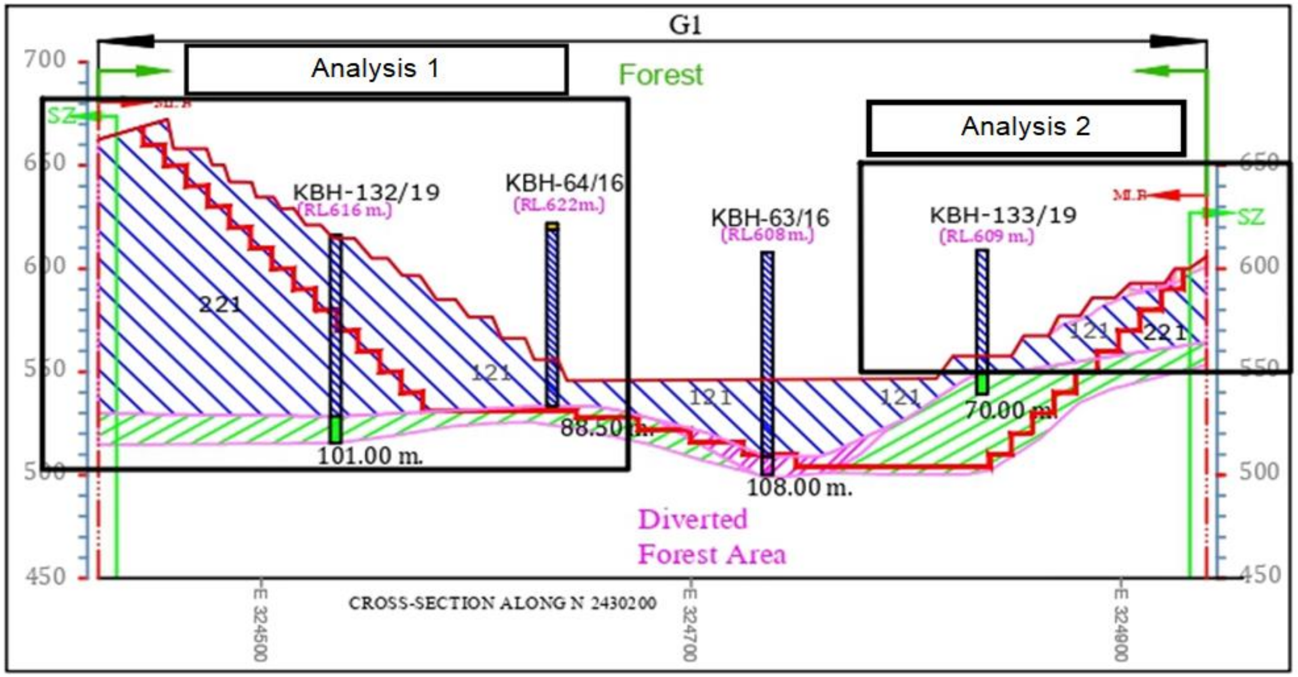


Figure 1 Nuagaon cross section N2430200

IRON FORMATION +55%

SHALE

LIMONITE

LATERITE

LATERITIC IRON ORE

GEOTHITE

BHJ-BHQ

IRON FORMATION 45%-55%

Analysis 1-E324500

1.1 DRY CONDITION [in-situ]

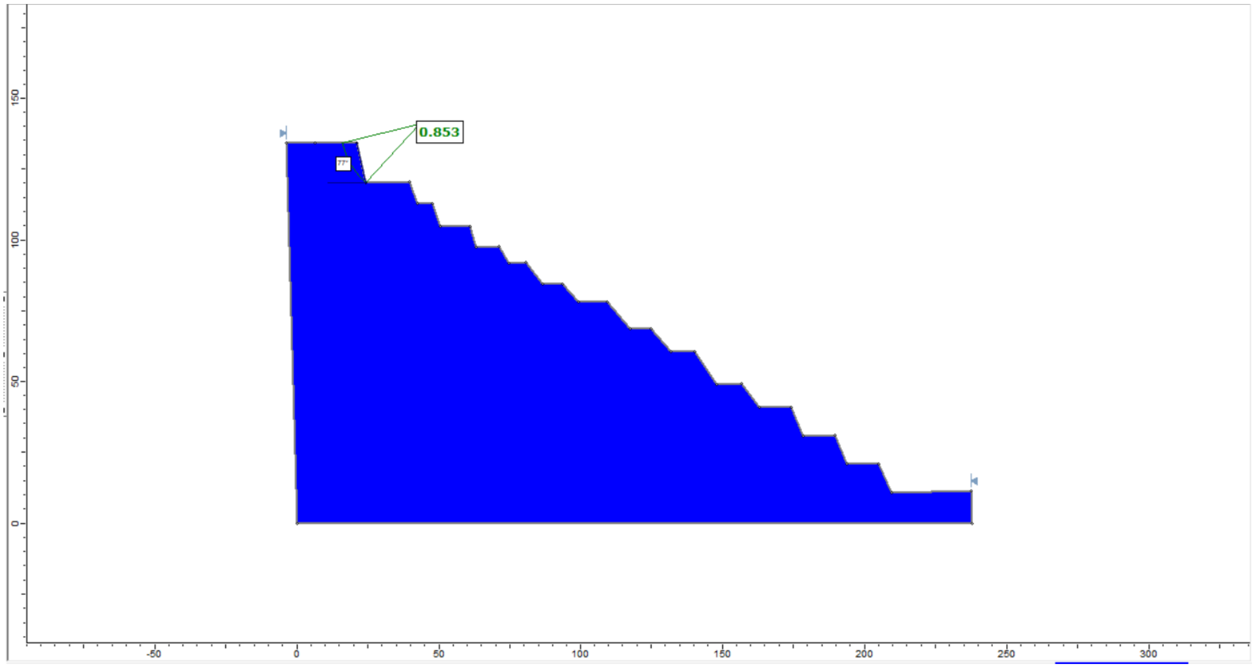


Figure 2 Slope stability analysis of a friable ore slope having FOS of 0.853

1.2 SATURATED CONDITION

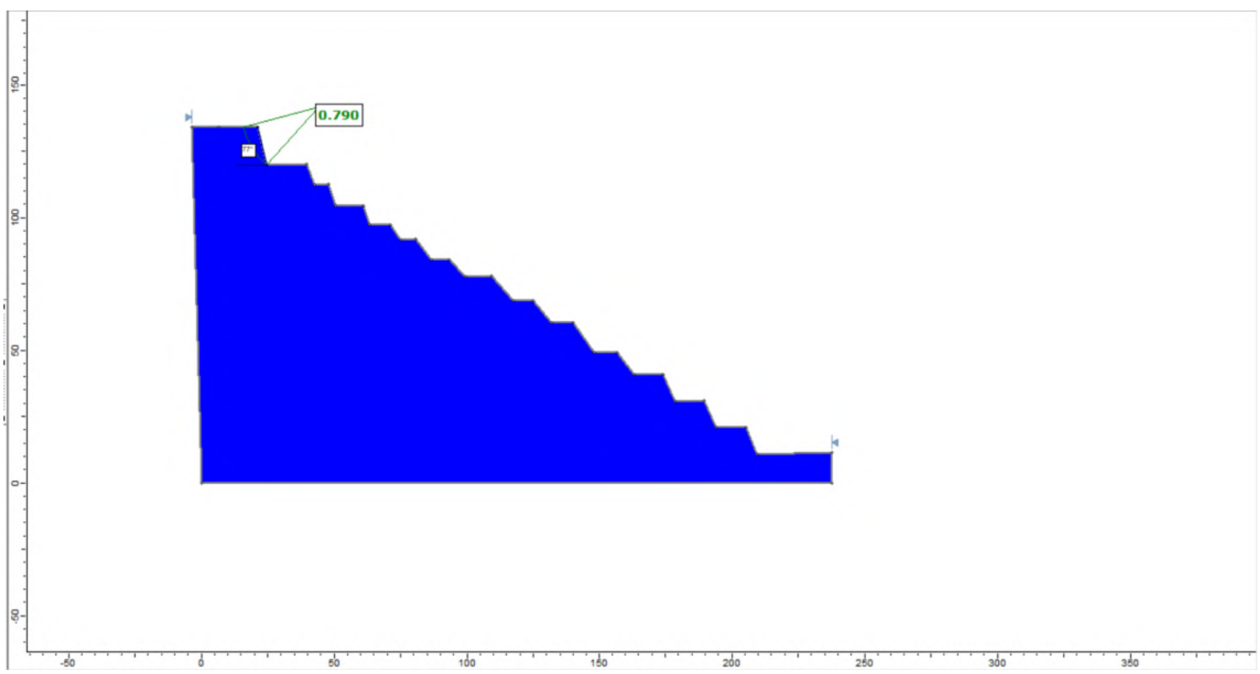


Figure 3 Slope stability analysis of a friable ore slope having FOS of 0.790

Analysis 2- E324900

2.1 DRY CONDITION [in-situ]

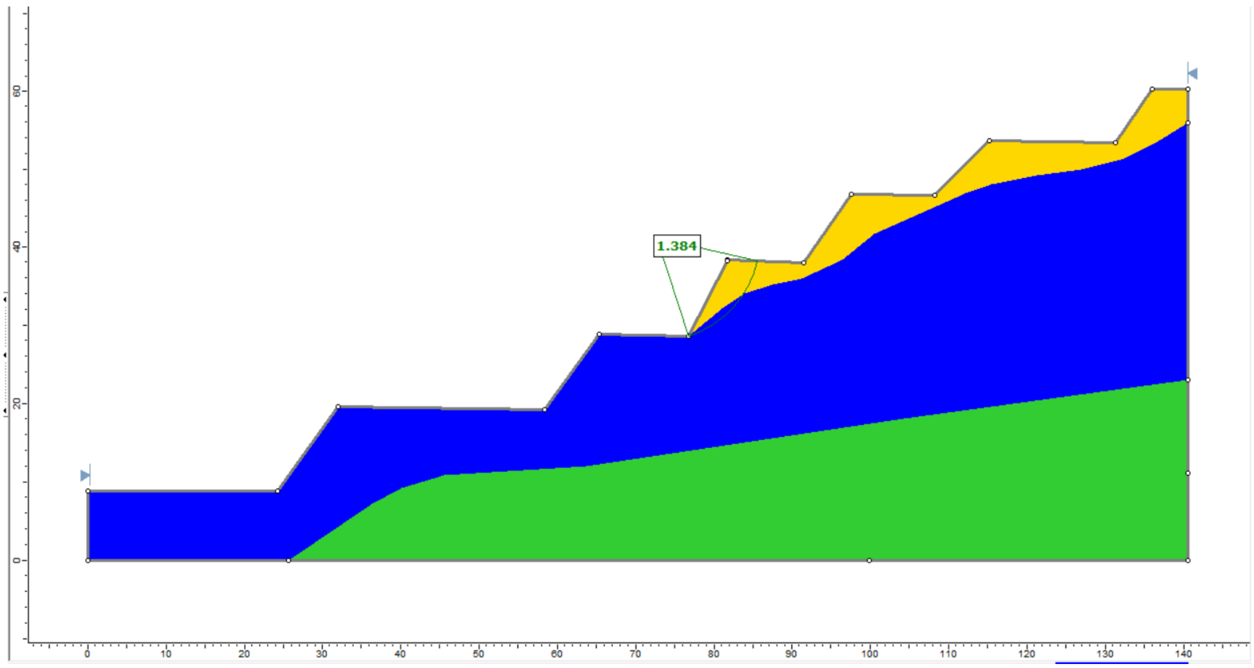


Figure 4 Slope stability analysis of a laterite slope having FOS of 1.384

2.2 SATURATED CONDITION

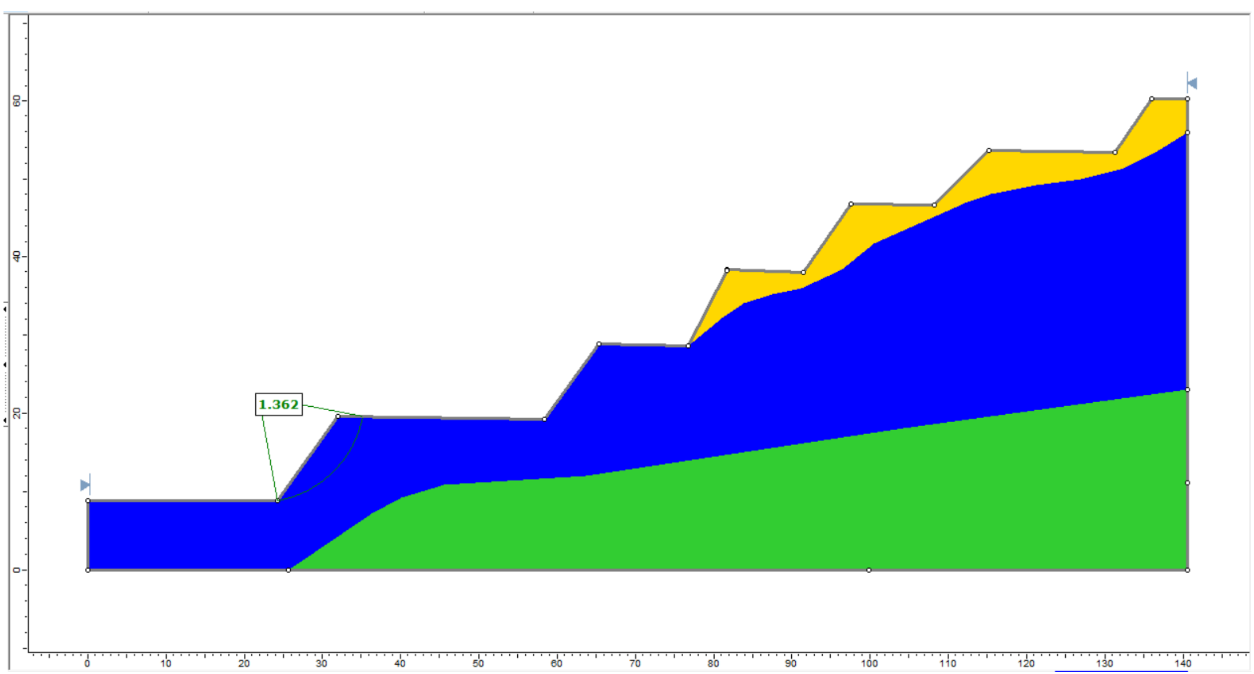


Figure 5 Slope stability analysis of a friable ore slope having FOS of 1.362

N2430100

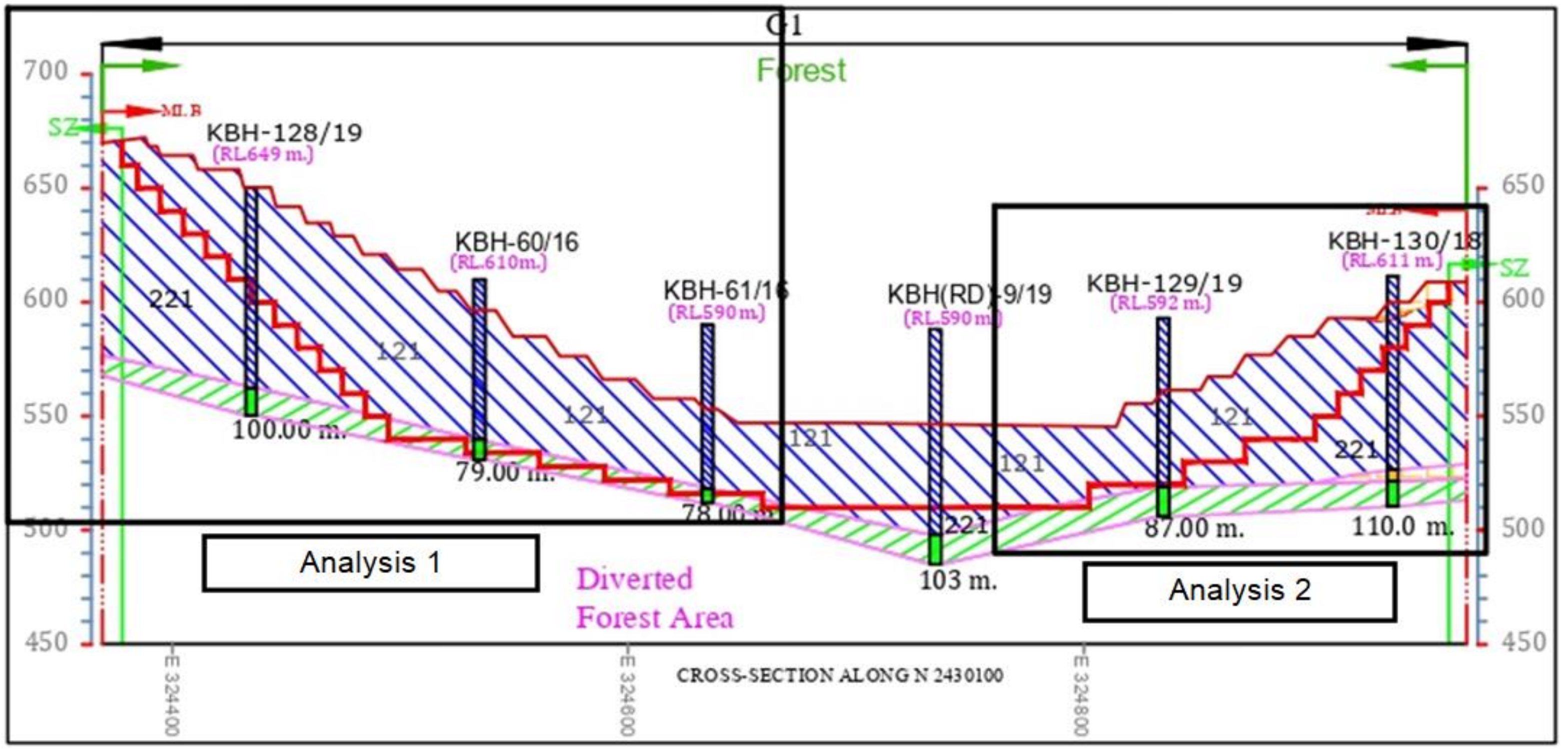
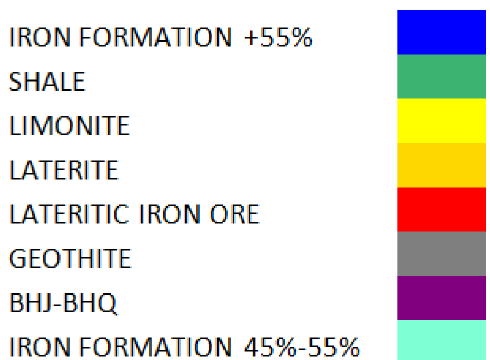


Figure 6 Nuagaon cross-section N2430100



Analysis 1 - E324400

DRY CONDITION [in-situ]

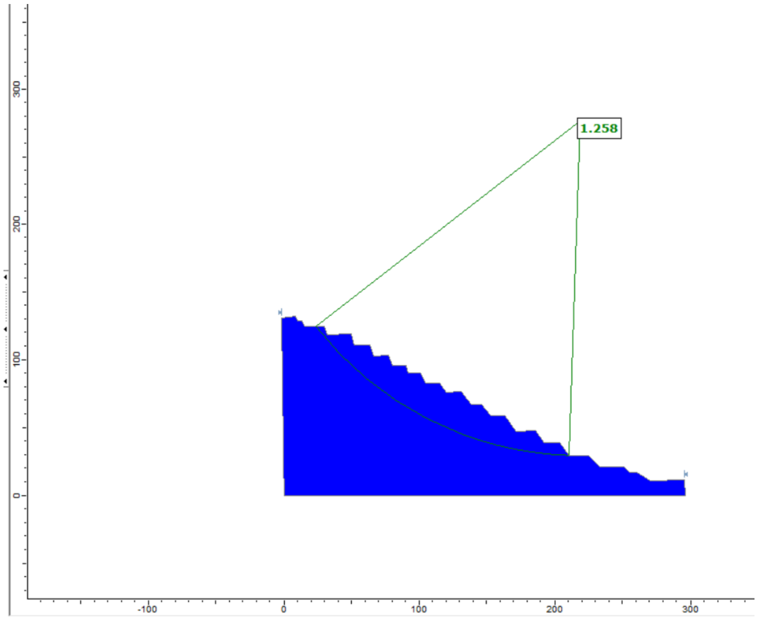


Figure 7 Slope stability analysis of a friable ore slope having FOS of 1.258

SATURATED CONDITION

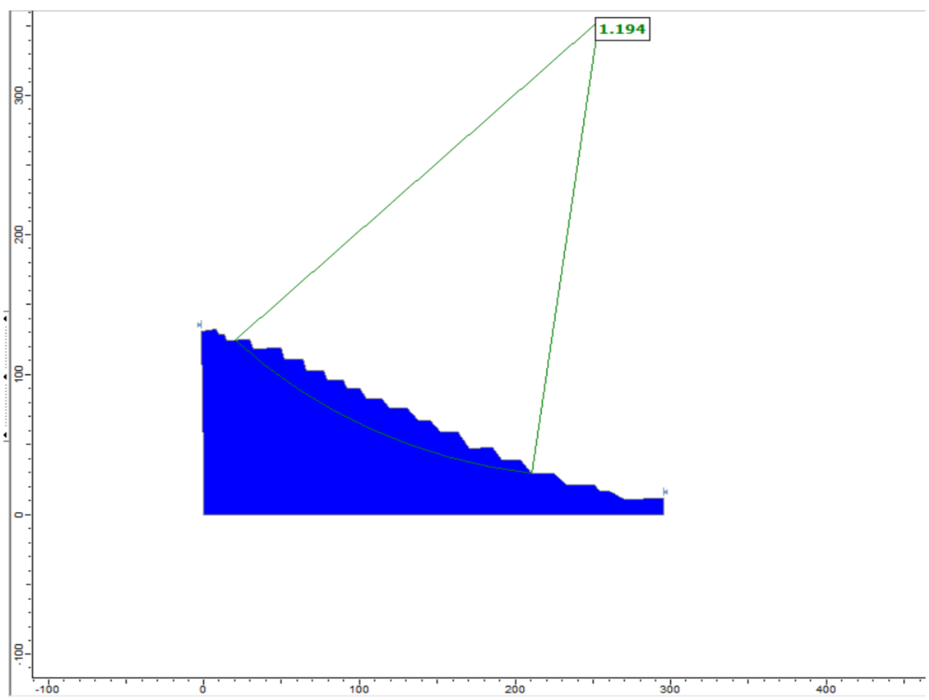


Figure 8 Slope stability analysis of a friable ore slope having FOS of 1.194

Analysis 2 - E324800

DRY CONDITION [in-situ]

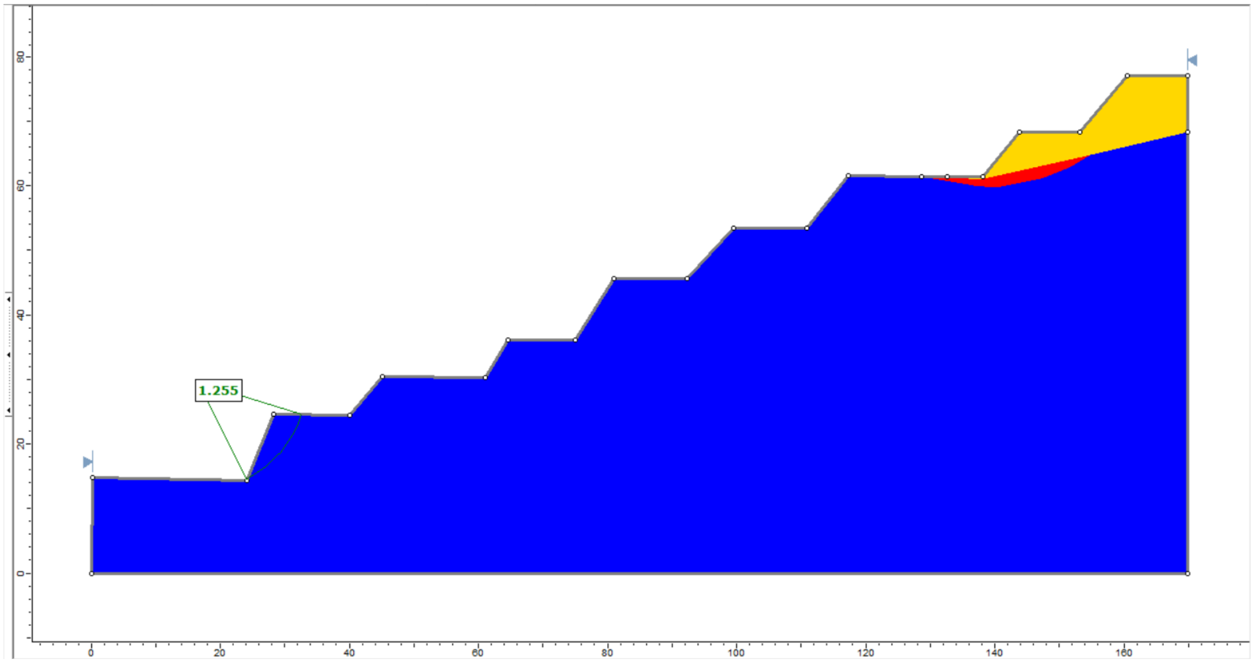


Figure 9 Slope stability analysis of a friable ore slope having FOS of 1.255

SATURATED CONDITION

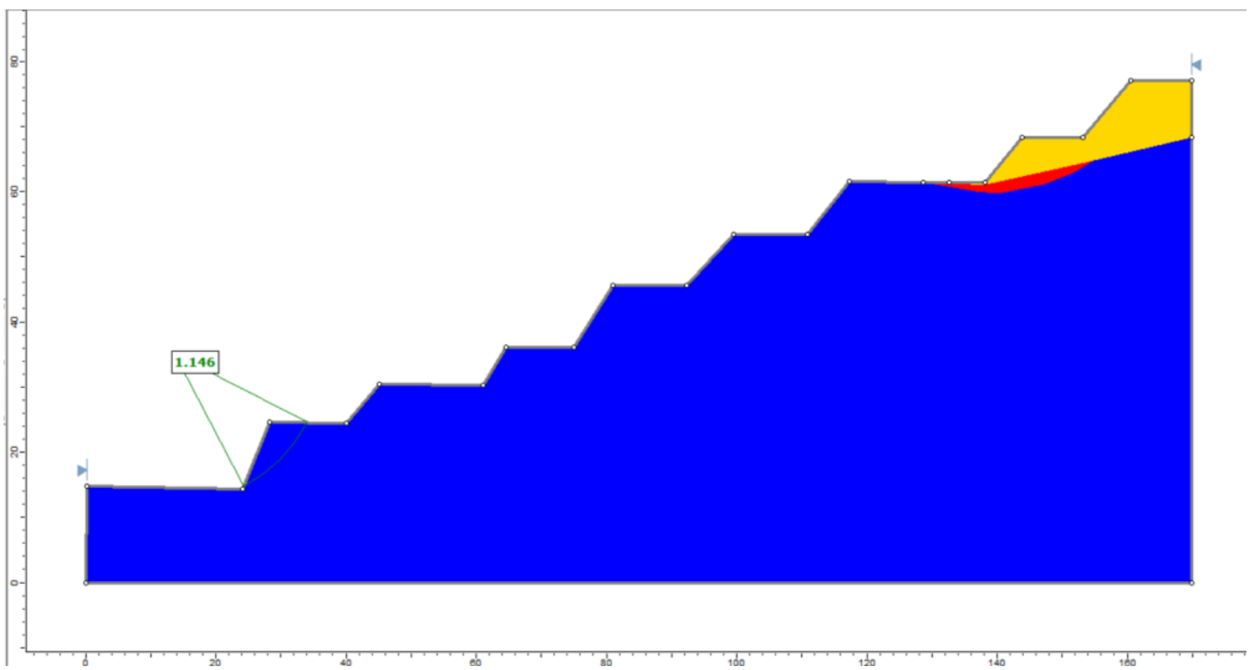


Figure 10 Slope stability analysis of a friable ore slope having FOS of 1.146

N2430000

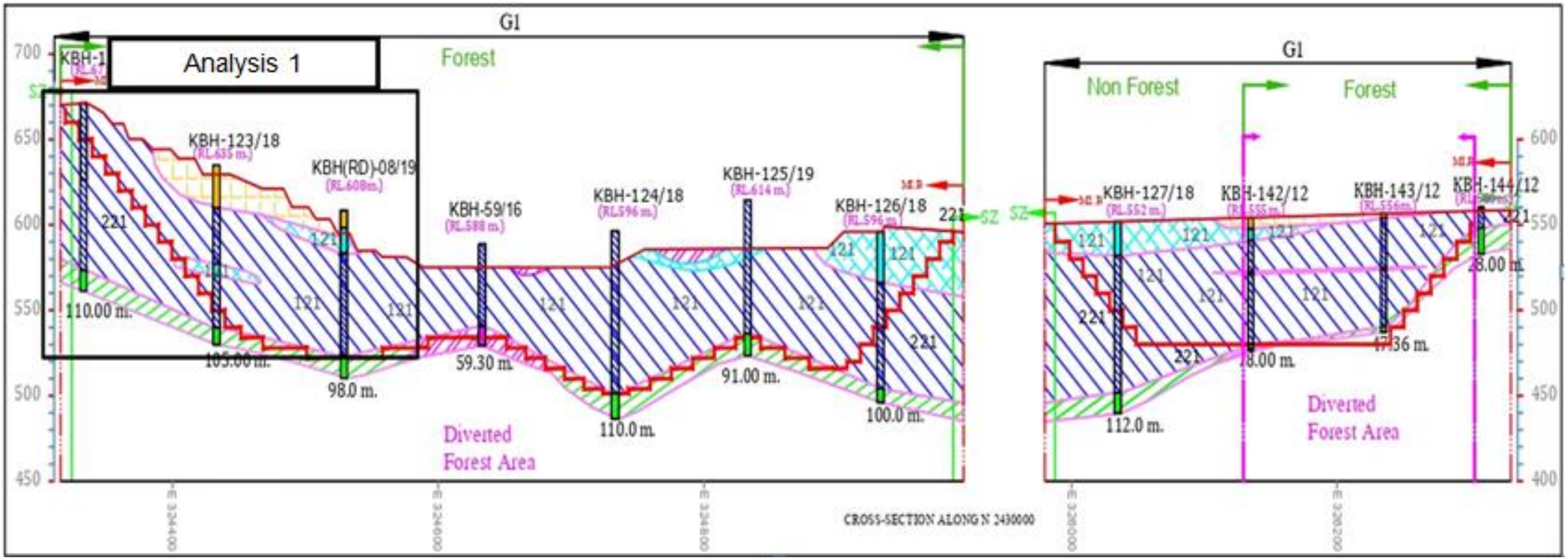


Figure 11 Nuagaon cross-section N2430000

IRON FORMATION +55%

SHALE

LIMONITE

LATERITE

LATERITIC IRON ORE

GEOTHITE

BHJ-BHQ

IRON FORMATION 45%-55%

Analysis 1

1.1 DRY CONDITION [in-situ]

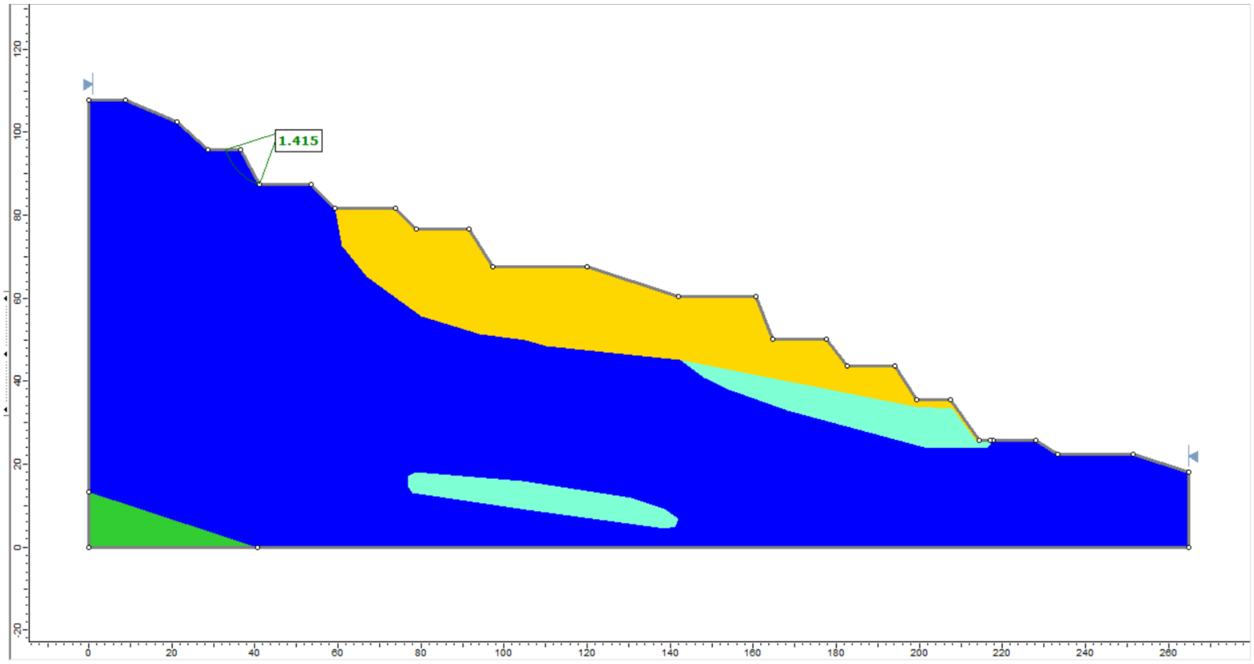


Figure 12 Slope stability analysis of a friable ore slope having FOS of 1.415

1.2 SATURATED CONDITION

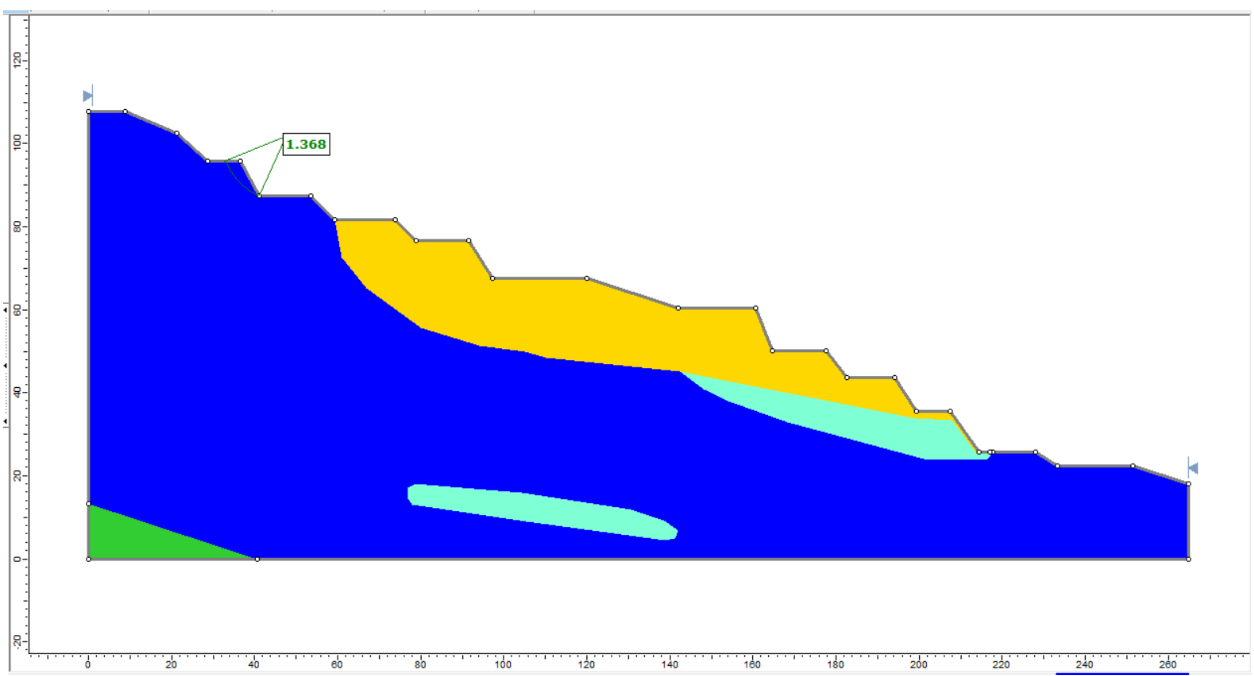


Figure 13 Slope stability analysis of a friable ore slope having FOS of 1.368

N2429900

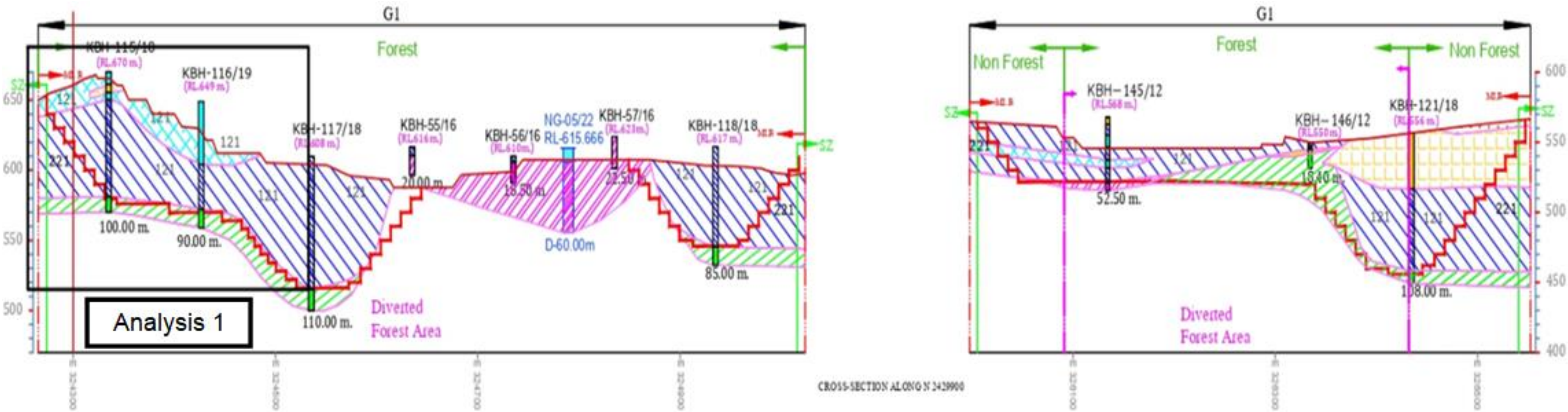


Figure 14 Nuagaon cross section N2429900

IRON FORMATION +55%

SHALE

LIMONITE

LATERITE

LATERITIC IRON ORE

GEOTHITE

BHJ-BHQ

IRON FORMATION 45%-55%

Analysis 1

DRY CONDITION [in-situ]

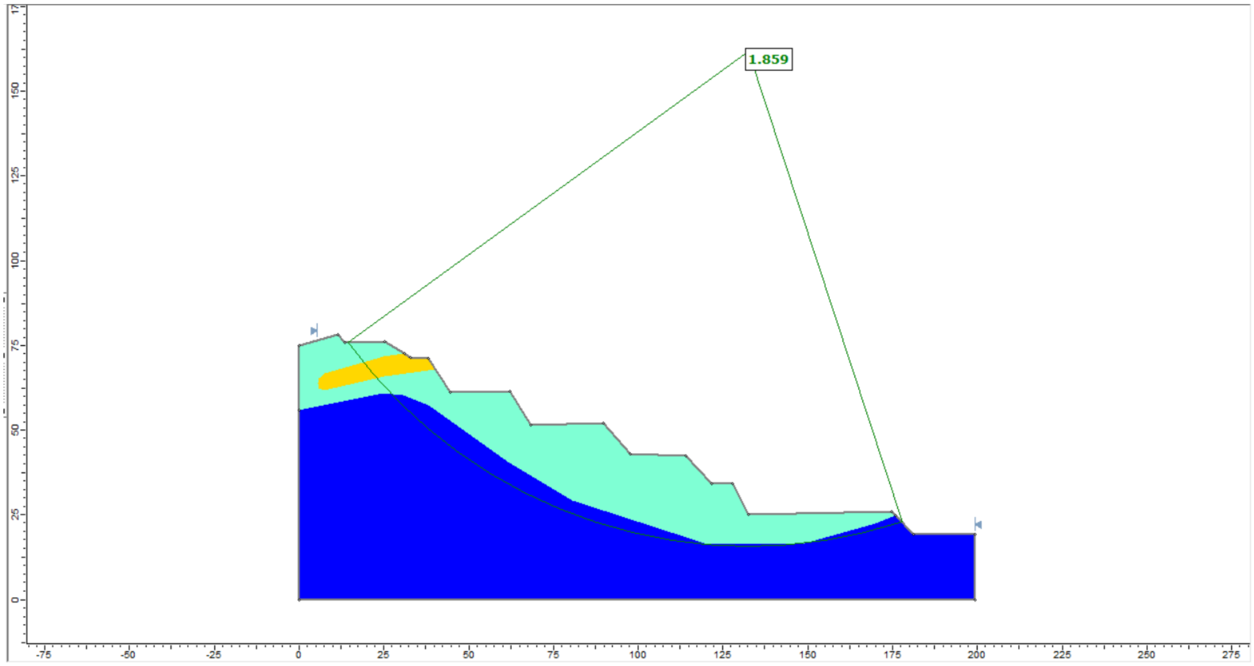


Figure 15 Slope stability analysis of a laterite and friable ore slope having FOS of 1.859

SATURATED CONDITION

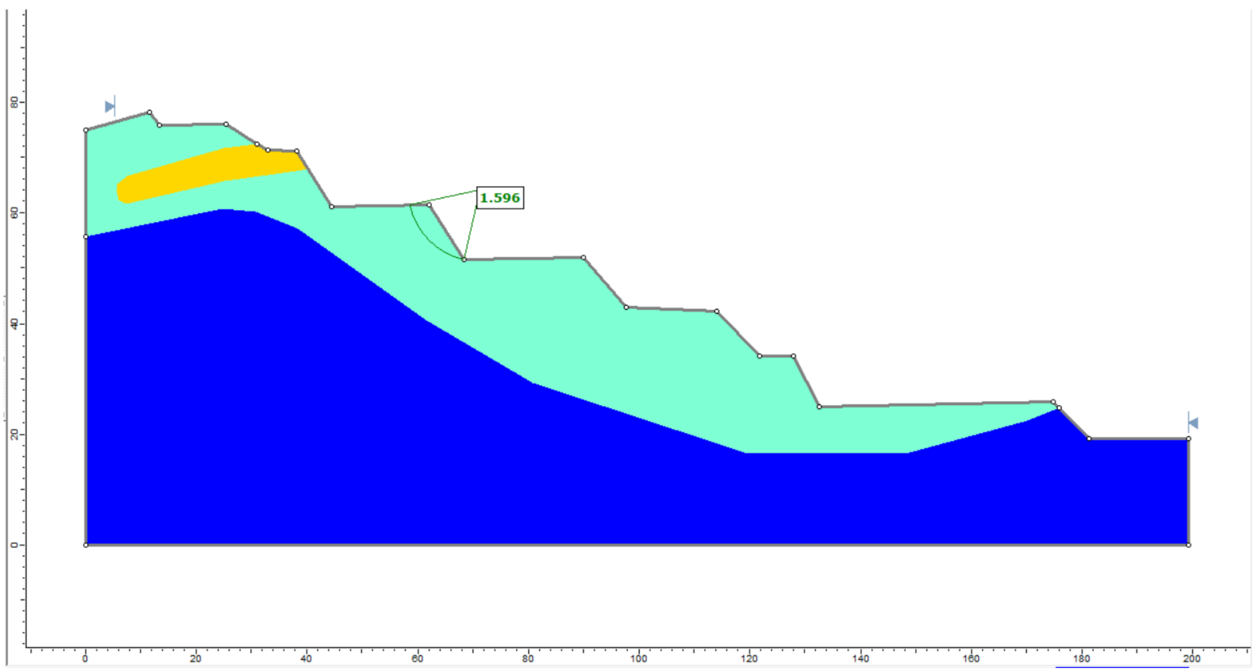


Figure 16 Slope stability analysis of a laterite and friable ore slope having FOS of 1.596

N 2429800

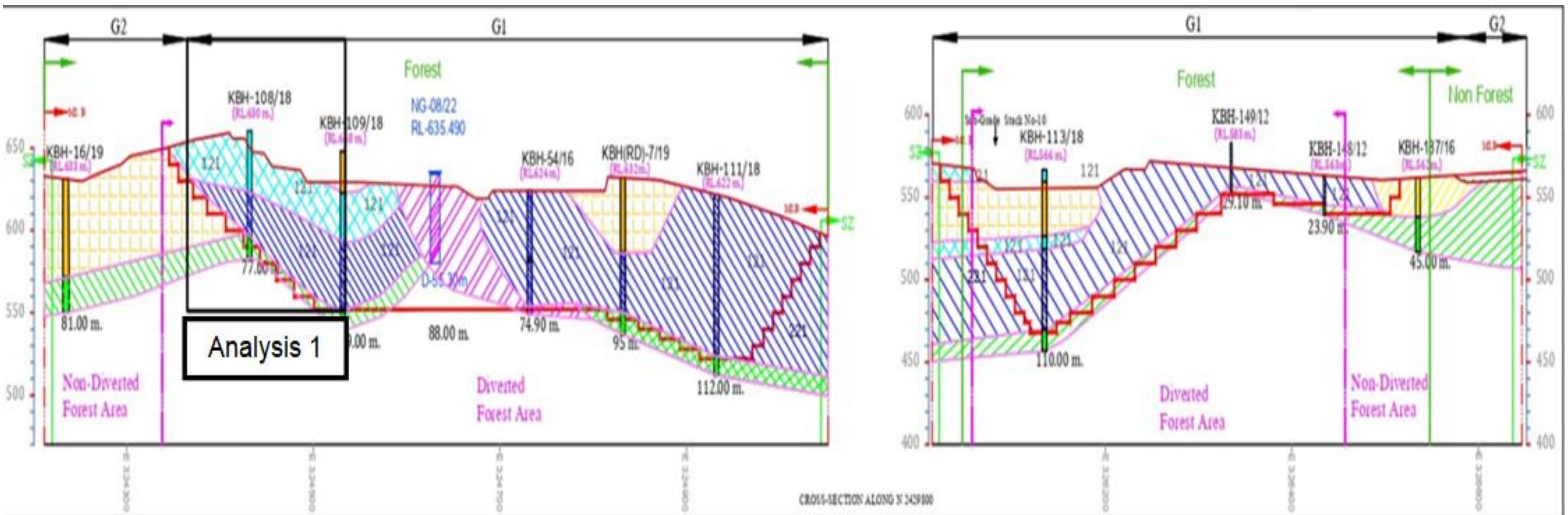
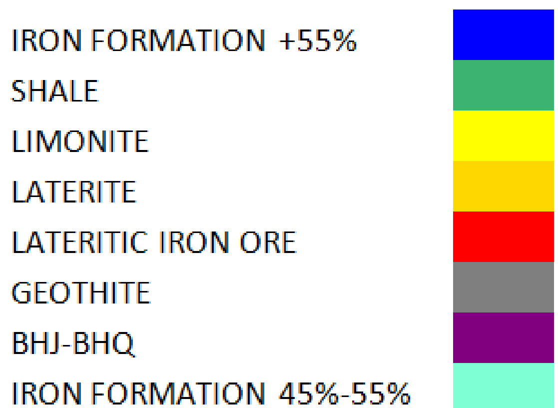


Figure 17 Nuagaon cross-section N 2429800



Analysis 1

1.1 DRY CONDITION [in-situ]

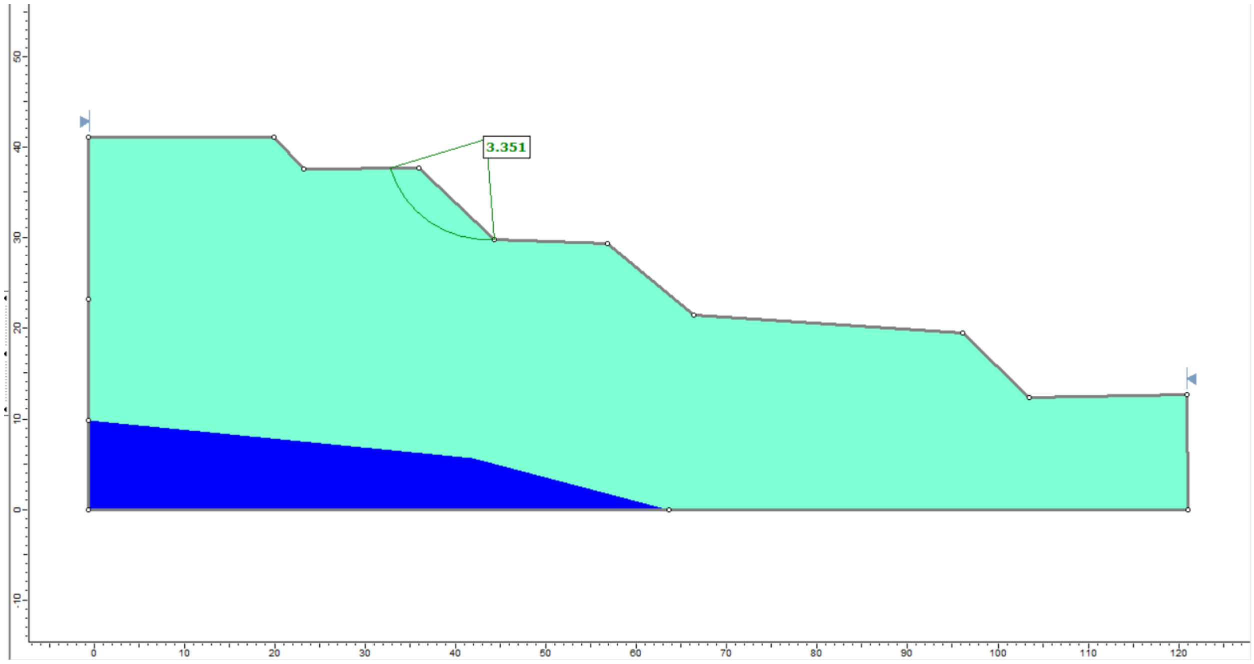


Figure 18 Slope stability analysis of a Iron Ore > 55% slope having FOS of 3.351

2.1 SATURATED CONDITION

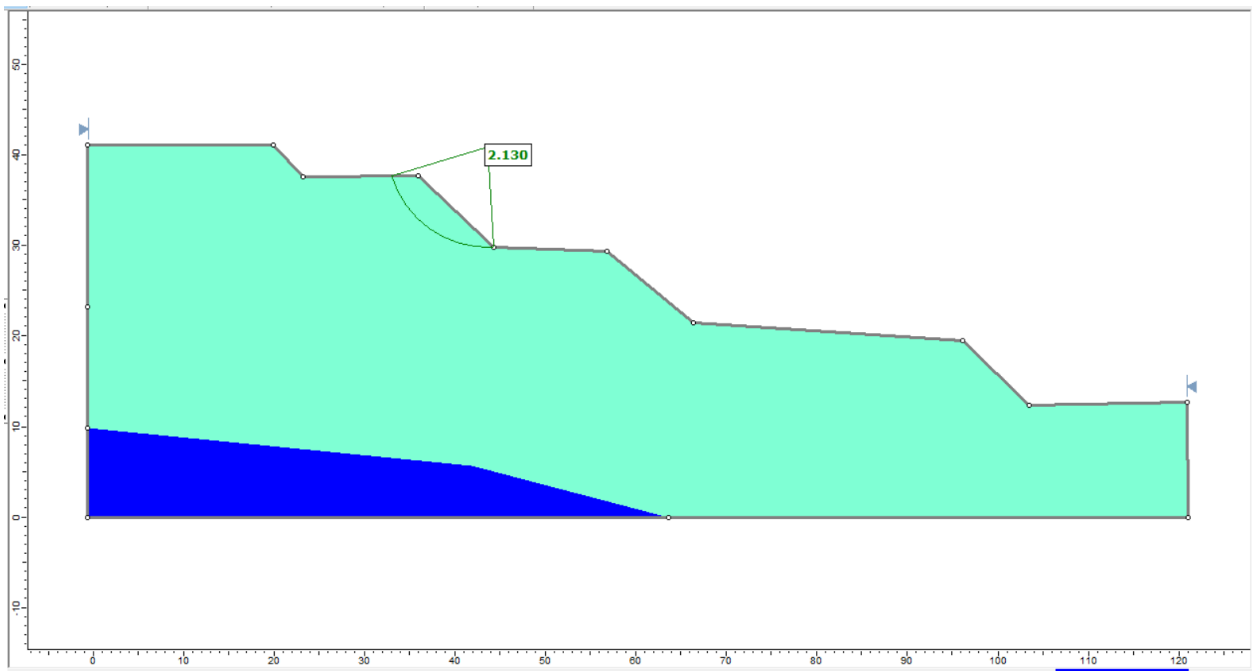


Figure 19 Slope stability analysis of a Iron Ore > 55% slope having FOS of 2.130

KANHUSAHI

N2429000

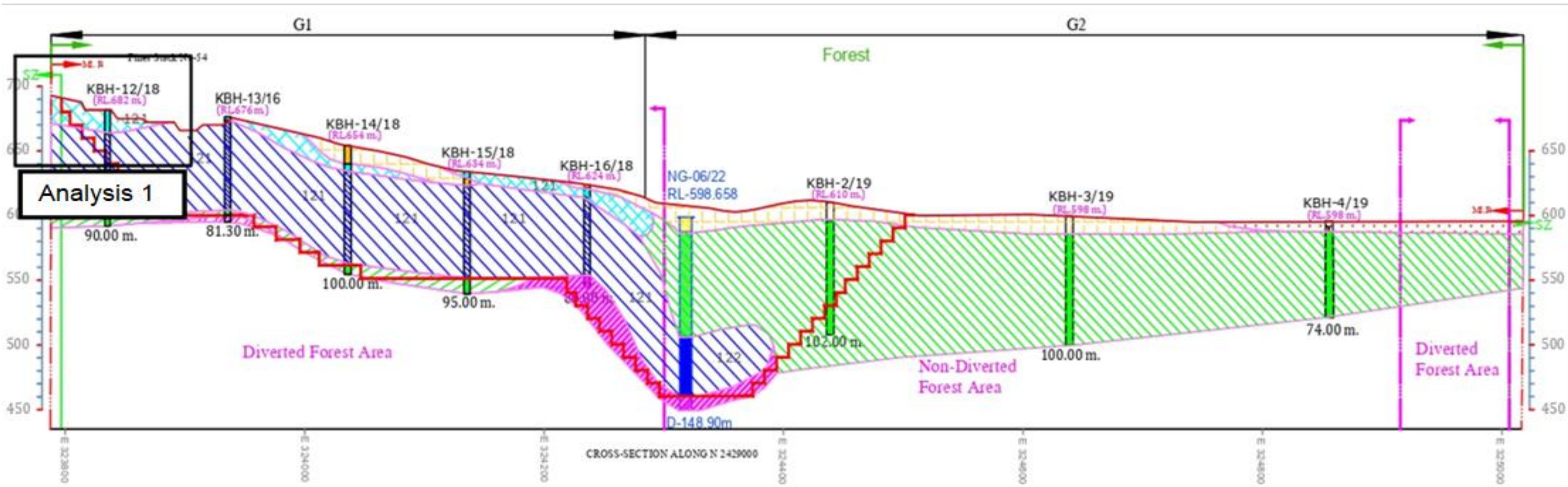


Figure 20 Nuagaon cross section N2429000

IRON FORMATION +55%	
SHALE	
LIMONITE	
LATERITE	
LATERITIC IRON ORE	
GEOTHITE	
BHJ-BHQ	
IRON FORMATION 45%-55%	

Analysis 1

1.1 DRY CONDITION [in-situ]

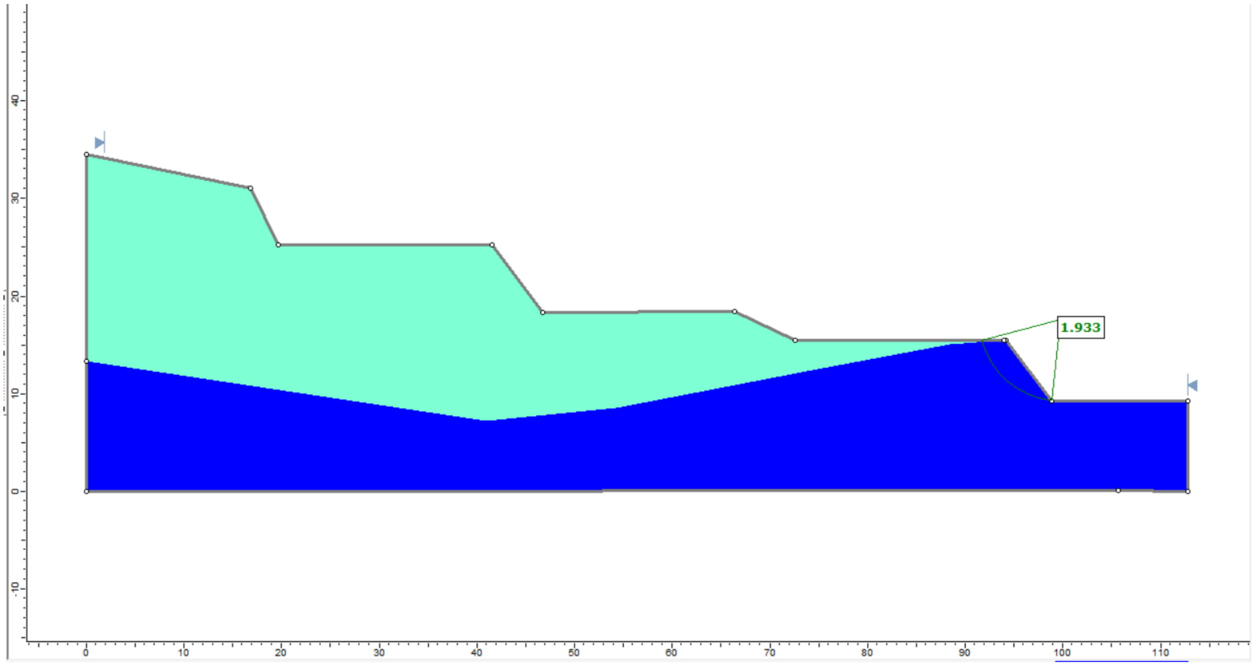


Figure 21 Slope stability analysis of a friable ore slope having FOS of 1.933

1.2 SATURATED CONDITION

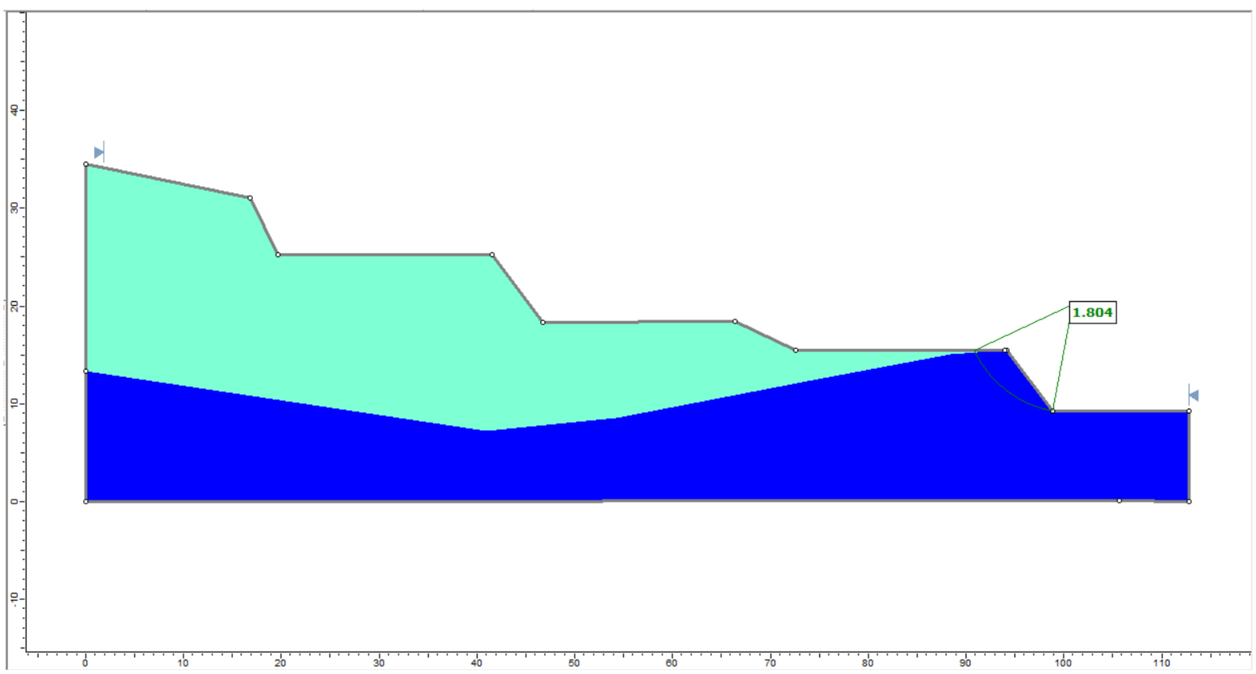


Figure 22 Slope stability analysis of a friable ore slope having FOS of 1.804

N2428900

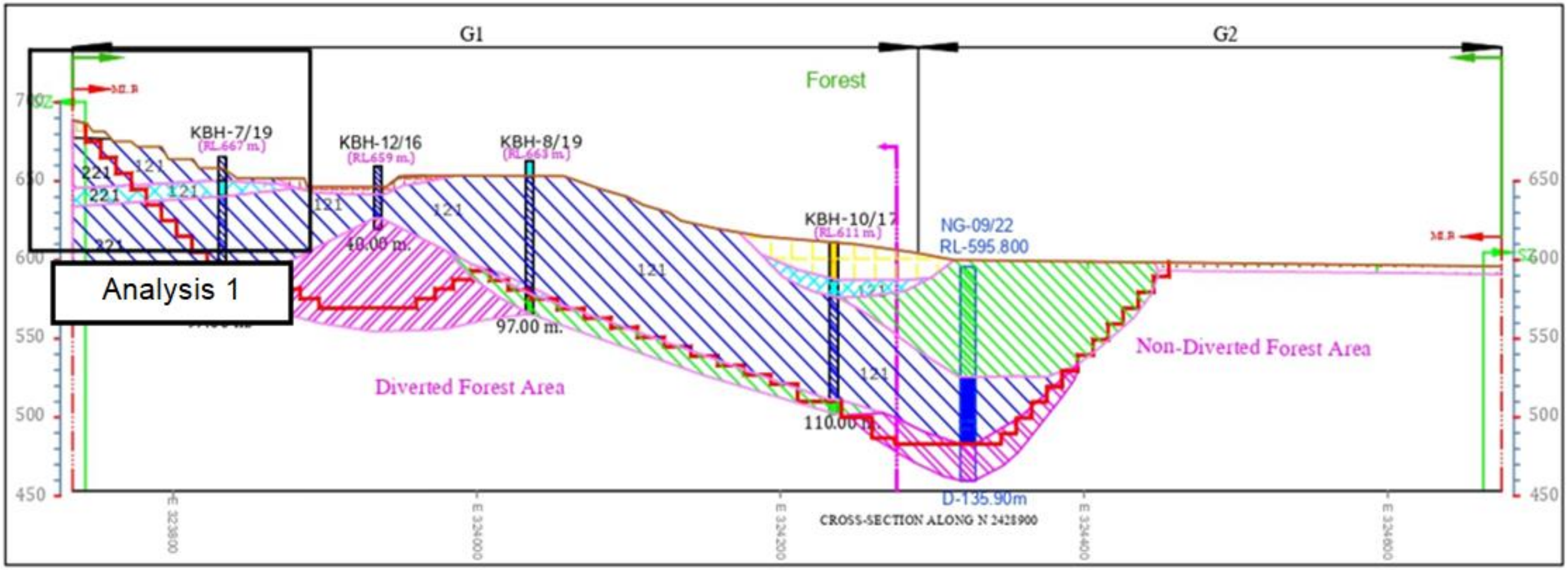
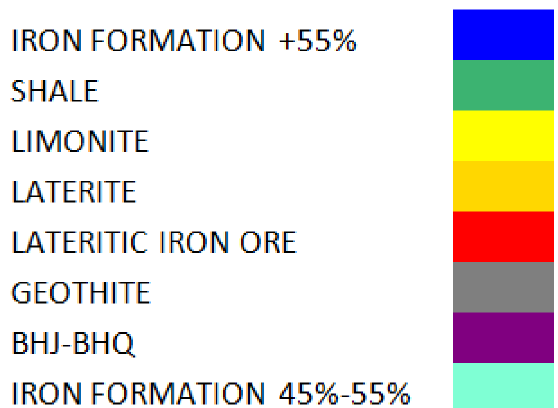


Figure 23 Nuagaon CROSS SECTION N2428900



Analysis 1

1.1 DRY CONDITION [in-situ]

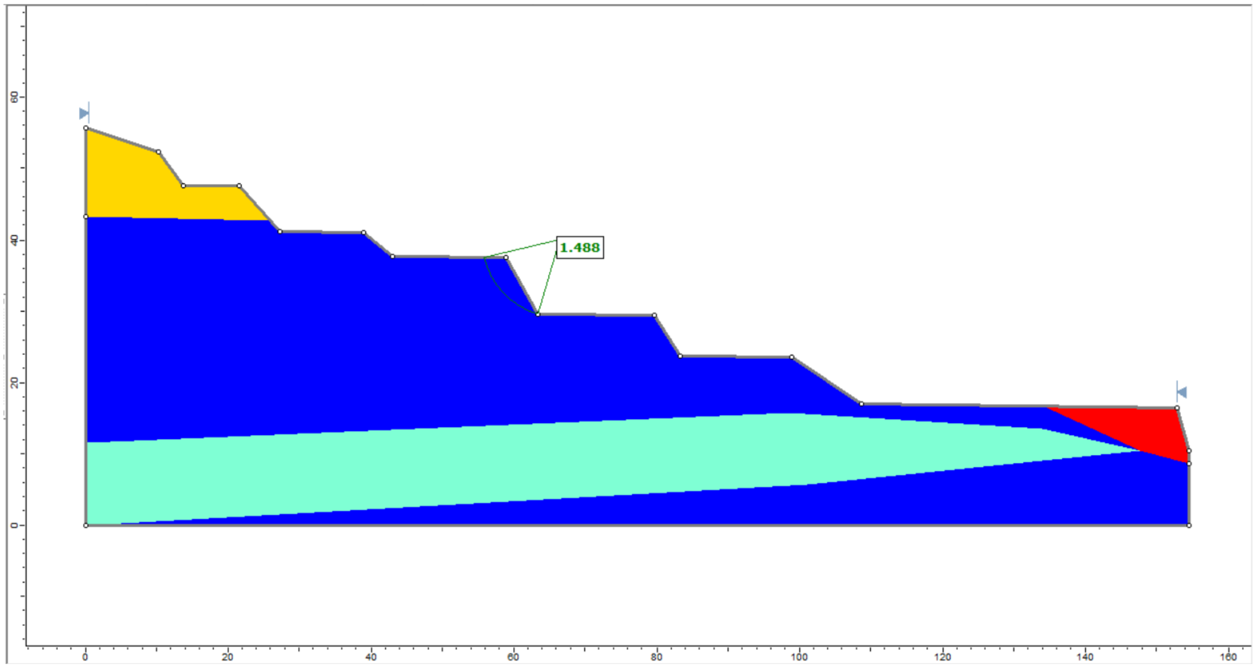


Figure 24 Slope stability analysis of a friable ore slope having FOS of 1.488

1.2 SATURATED CONDITION

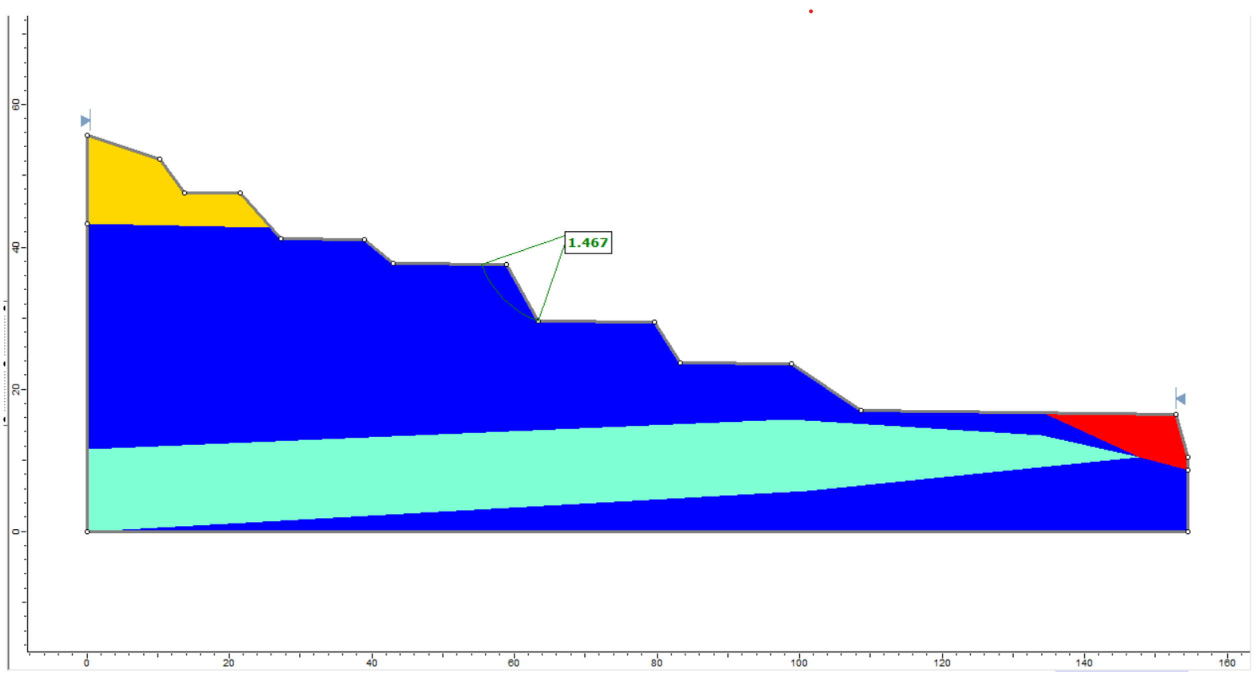


Figure 25 Slope stability analysis of a friable ore slope having FOS of 1.467

N2428800

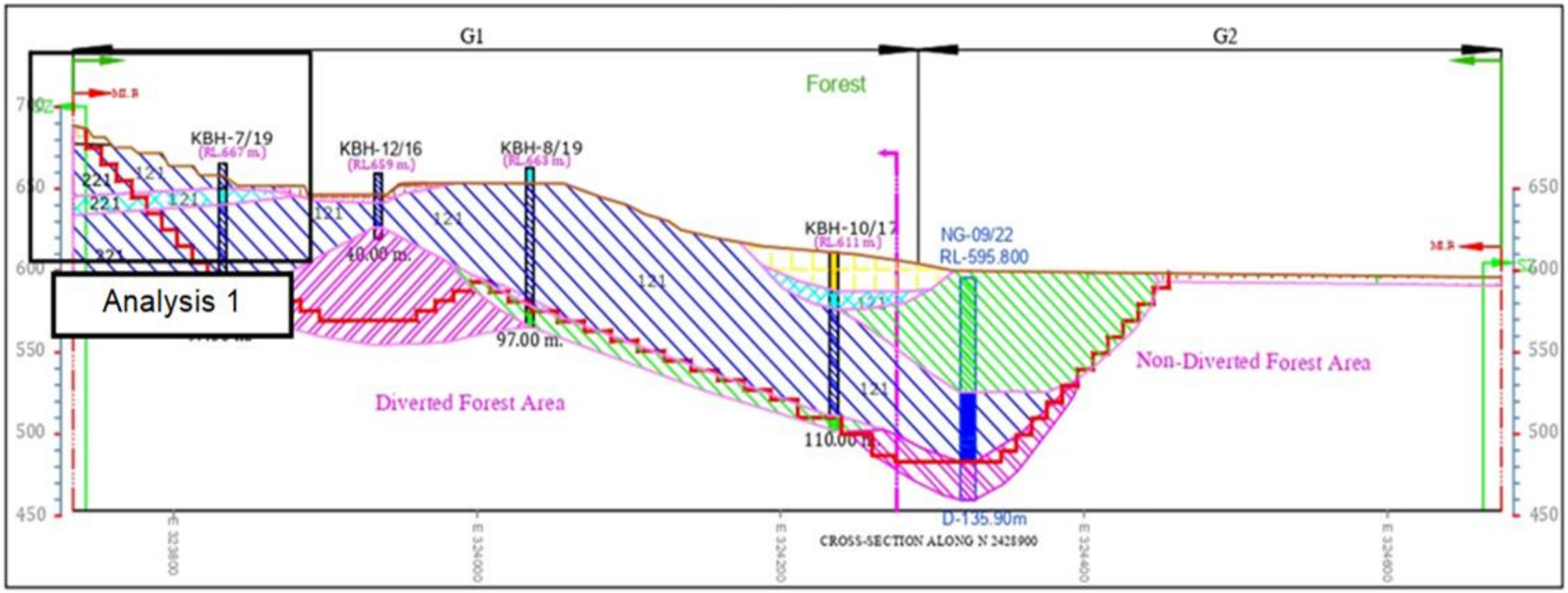


Figure 26 Nuagaon cross section N2428800

IRON FORMATION +55%	
SHALE	
LIMONITE	
LATERITE	
LATERITIC IRON ORE	
GEOTHITE	
BHJ-BHQ	
IRON FORMATION 45%-55%	

Analysis 1

1.1 DRY CONDITION [in-situ]

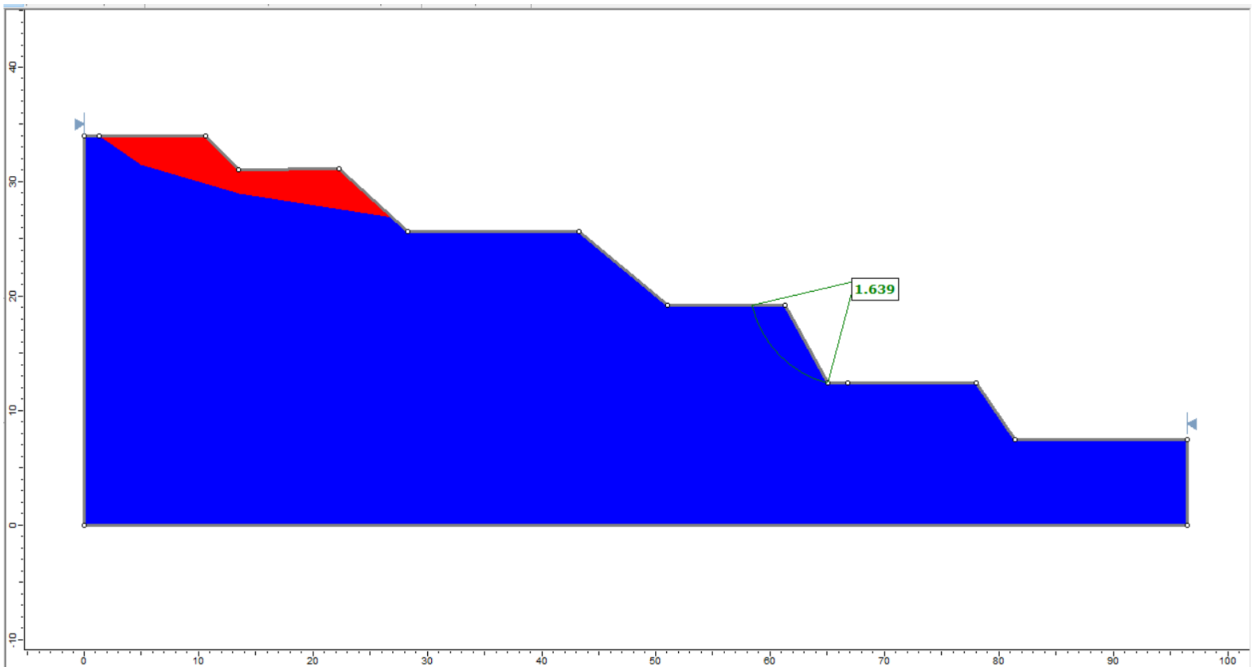


Figure 27 Slope stability analysis of a friable ore slope having FOS of 1.639

1.2 SATURATED CONDITION

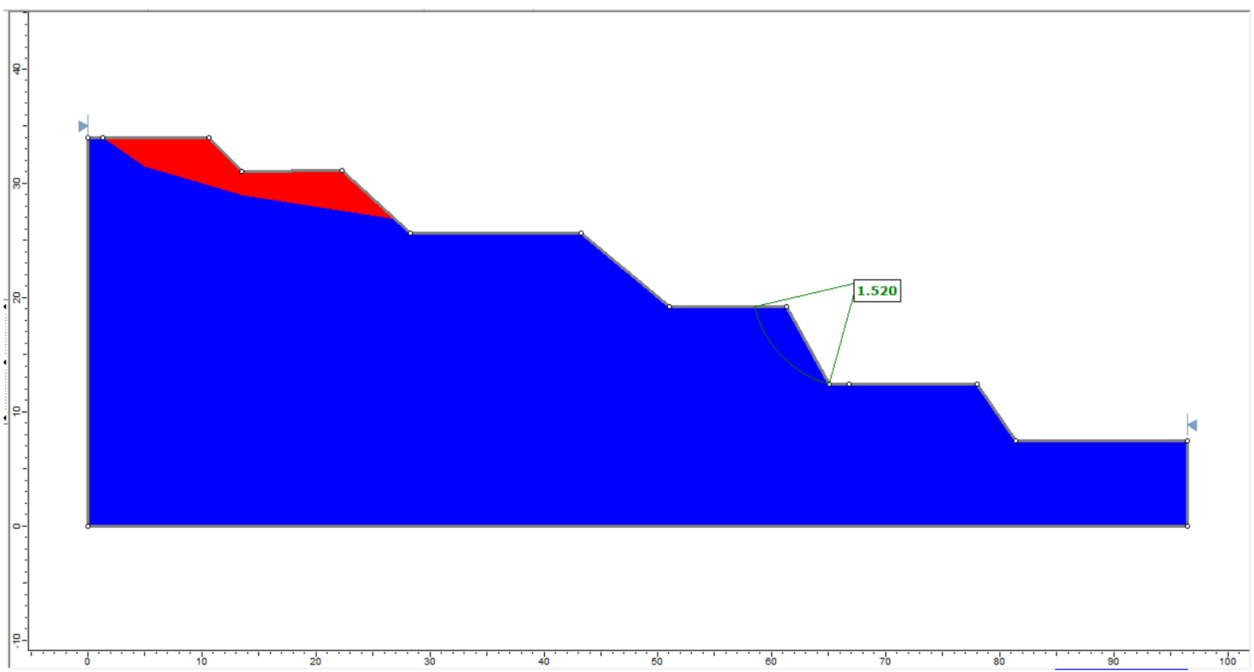


Figure 28 Slope stability analysis of a friable ore slope having FOS of 1.520

MDH QUARRY

N2430900

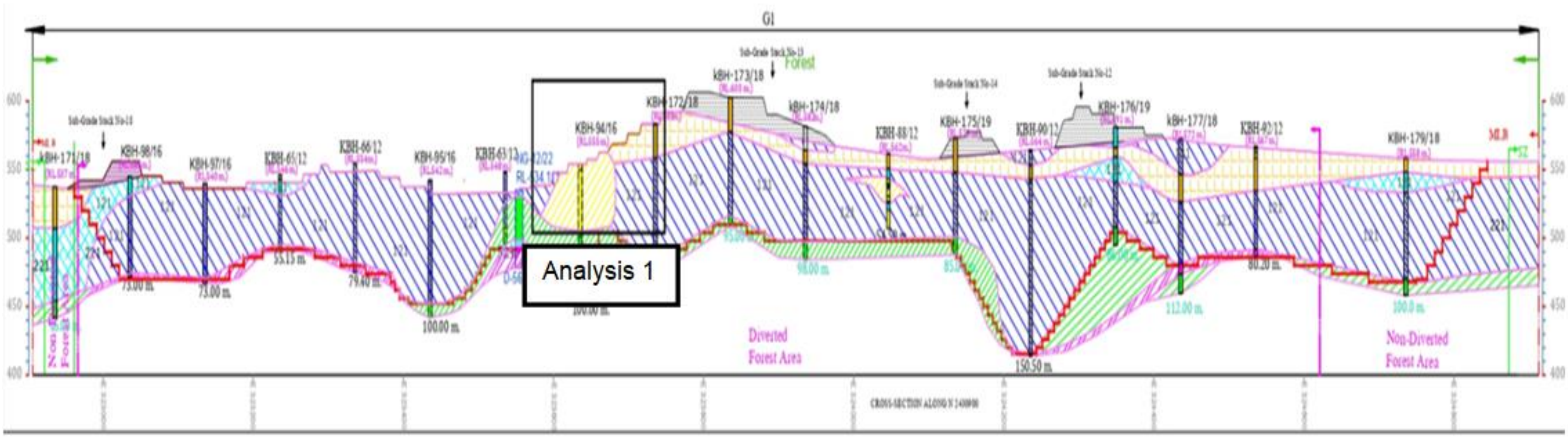


Figure 29 Nuagaon cross section N2430900

IRON FORMATION +55%
SHALE
LIMONITE
LATERITE
LATERITIC IRON ORE
GEOTHITE
BHJ-BHQ
IRON FORMATION 45%-55%

Analysis 1

1.1 DRY CONDITION [in-situ]

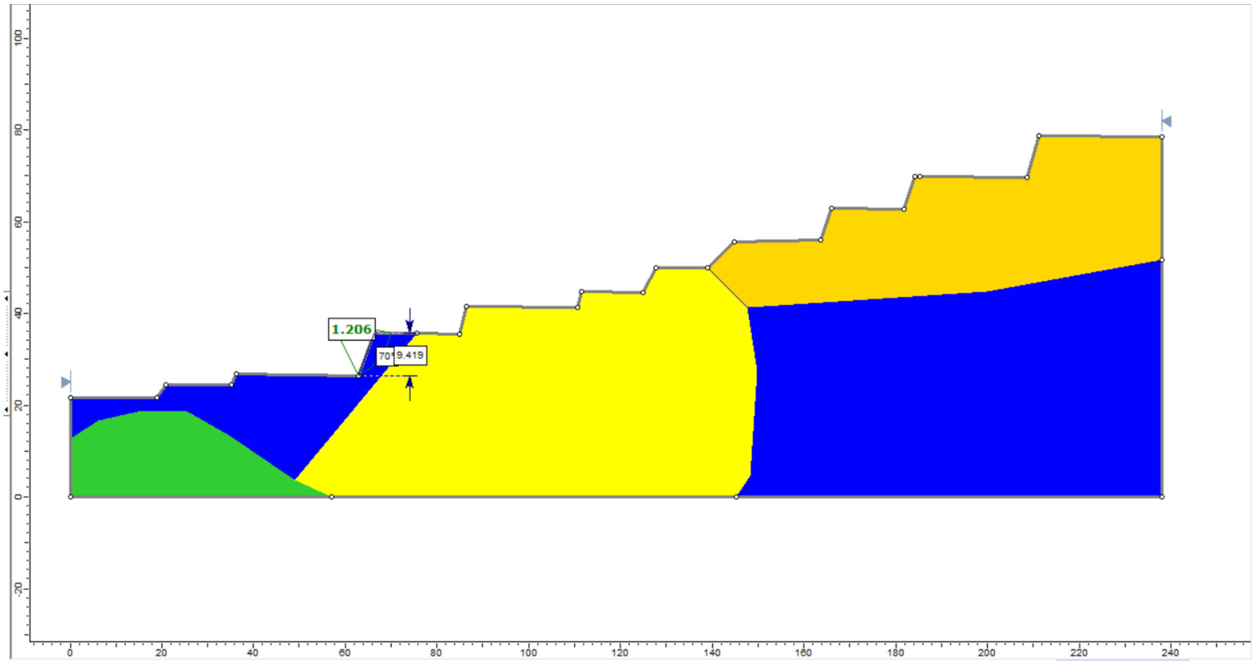


Figure 30 Slope stability analysis of a friable ore slope having bench height 9.4 m and bench angle 70, showing FOS of 1.206

1.2 SATURATED CONDITION

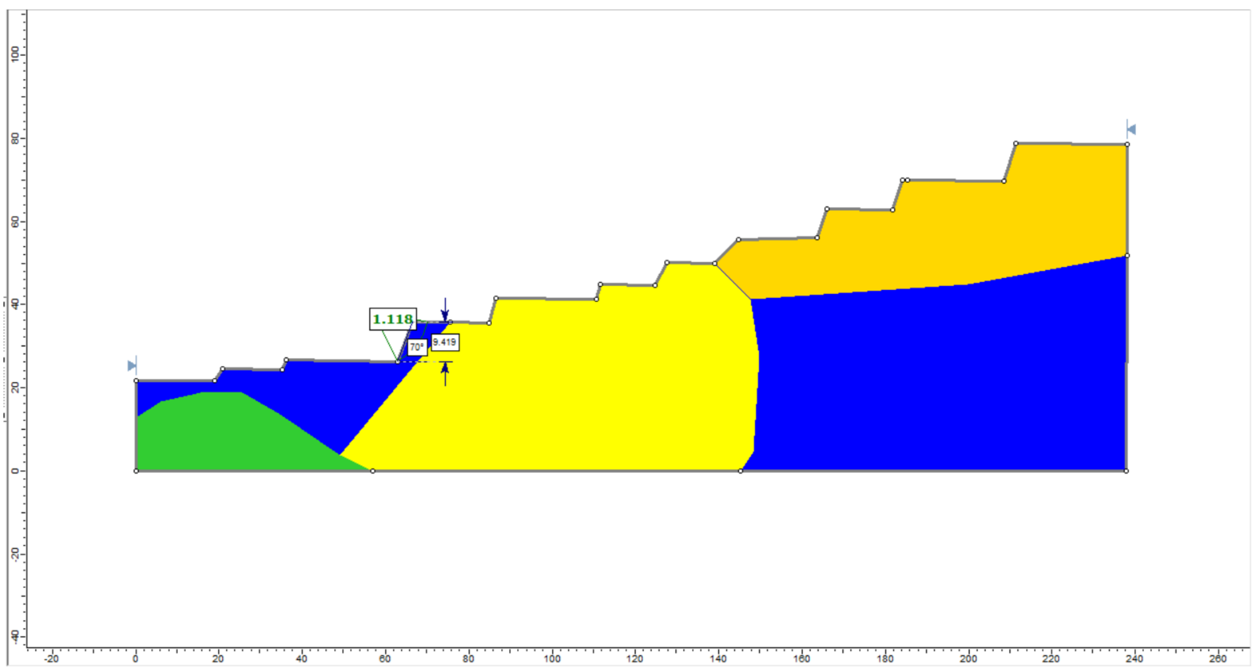


Figure 31 Slope stability analysis of a friable ore slope having bench height 9.4 m and bench angle 70, showing FOS of 1.118

<u>**N2430800**</u>

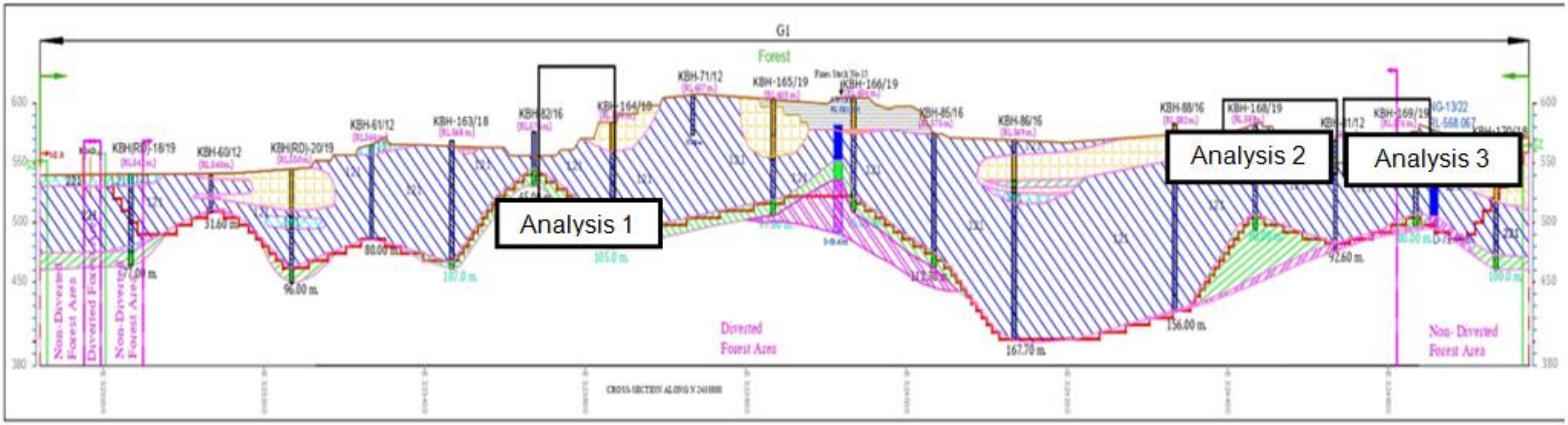
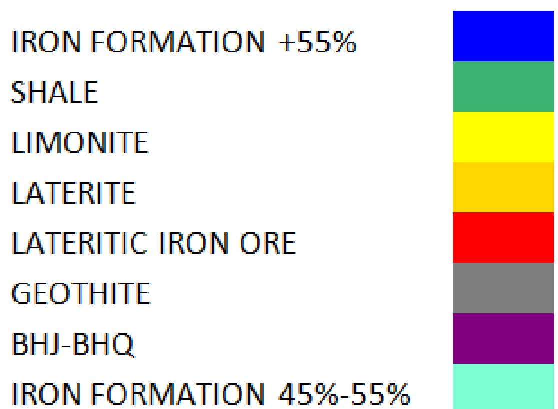


Figure 32 Nuagaon cross section N2430800



Analysis 1-E323600

1.1 DRY CONDITION [in-situ]

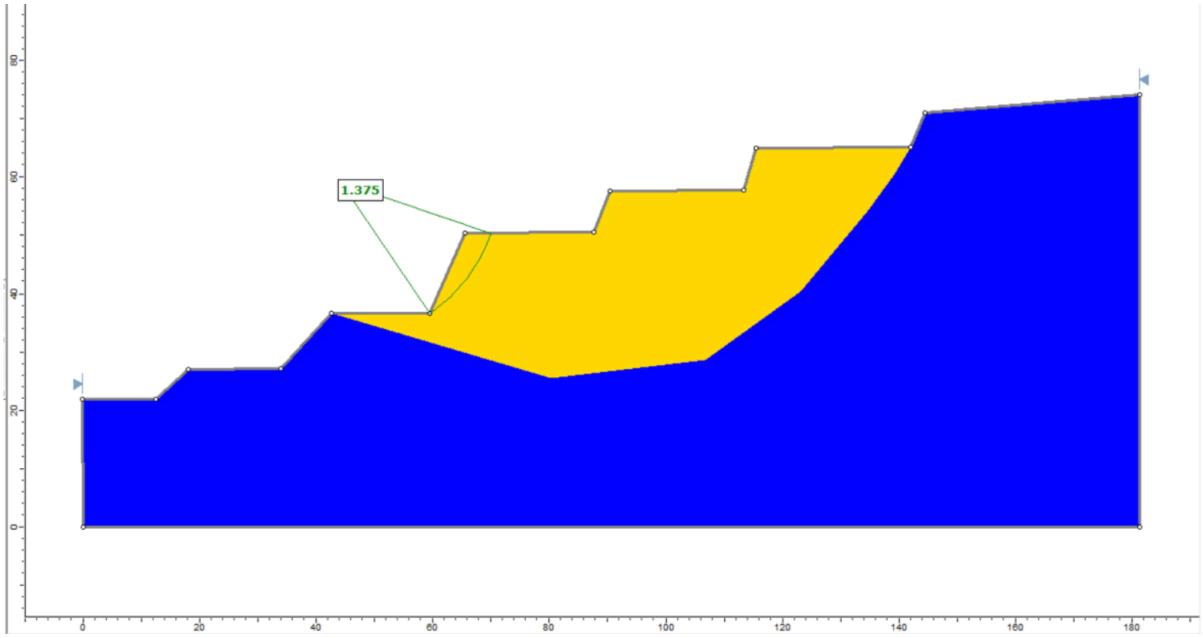


Figure 33 Slope stability analysis of a laterite slope having FOS of 1.375

1.2 SATURATED CONDITION

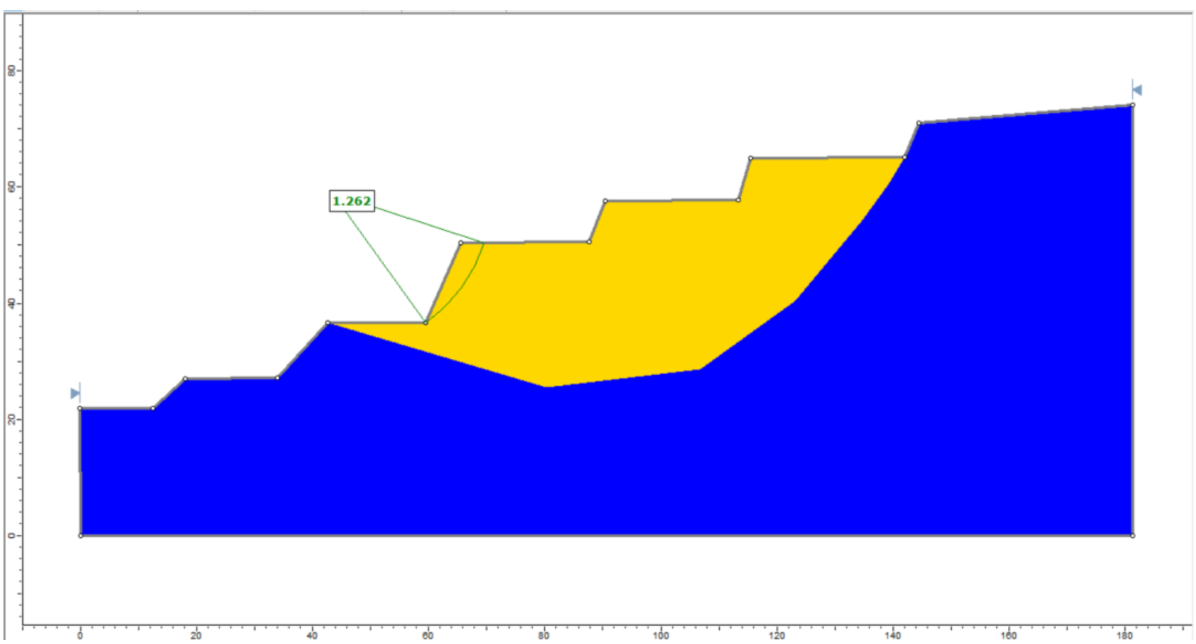


Figure 34 Slope stability analysis of a laterite slope having FOS of 1.262

Analysis 2-E324400

2.1 DRY CONDITION [in-situ]

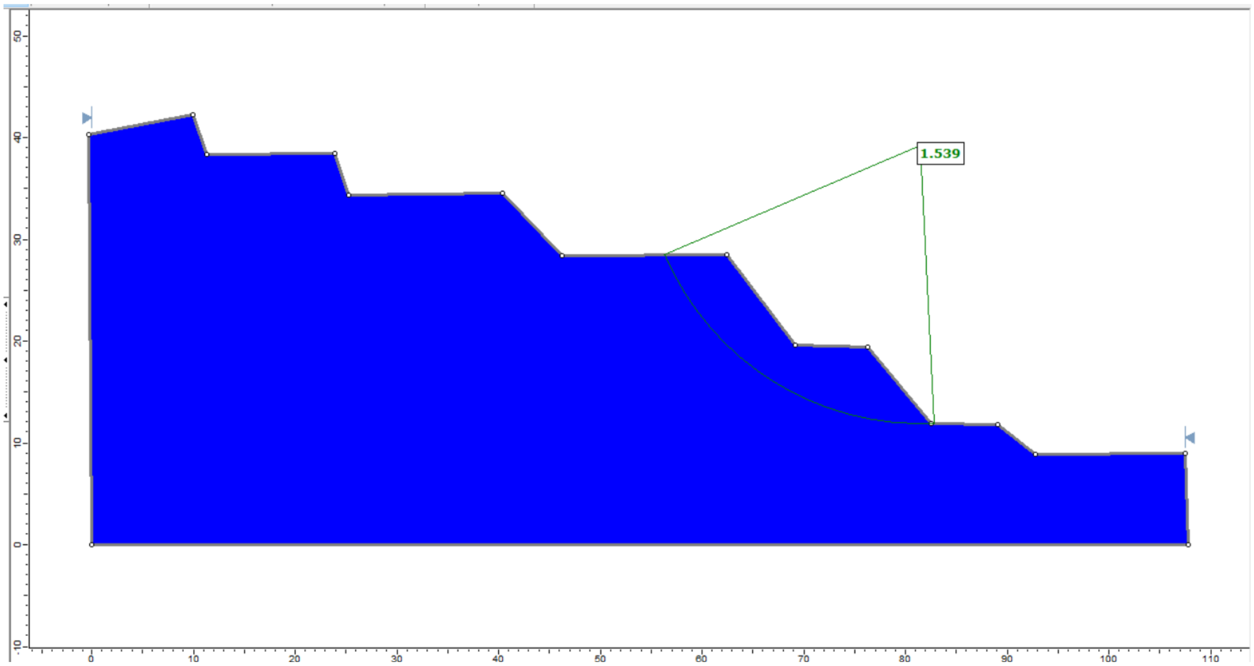


Figure 35 Slope stability analysis of a friable ore slope having FOS of 1.539

2.2 SATURATED CONDITION

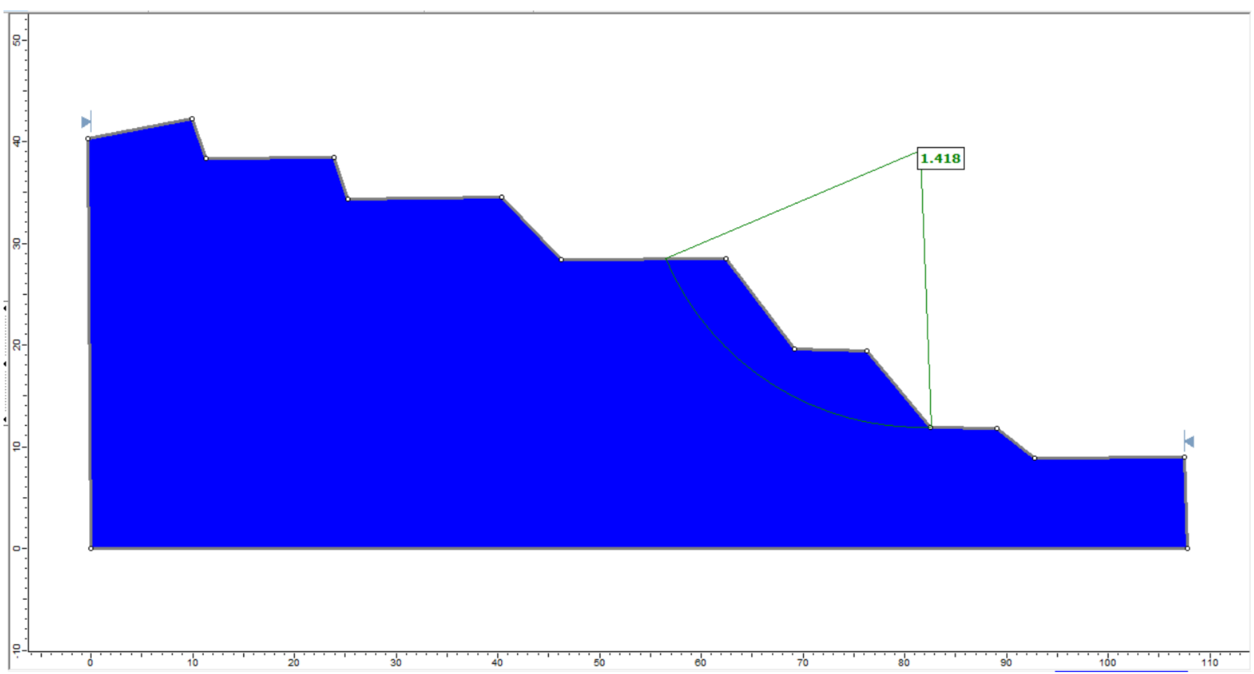


Figure 36 Slope stability analysis of a friable ore slope having FOS of 1.418

Analysis 3-E324600

3.1 DRY CONDITION [in-situ]

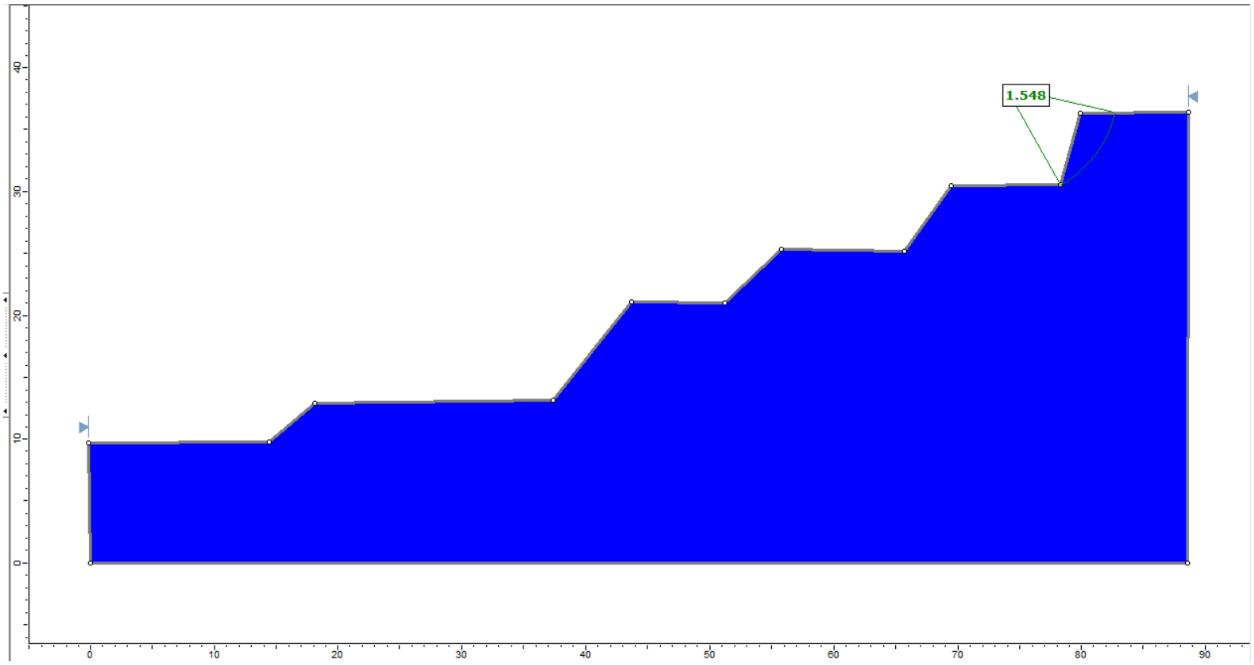


Figure 37 Slope stability analysis of a friable ore slope having FOS of 1.548

3.2 SATURATED CONDITION

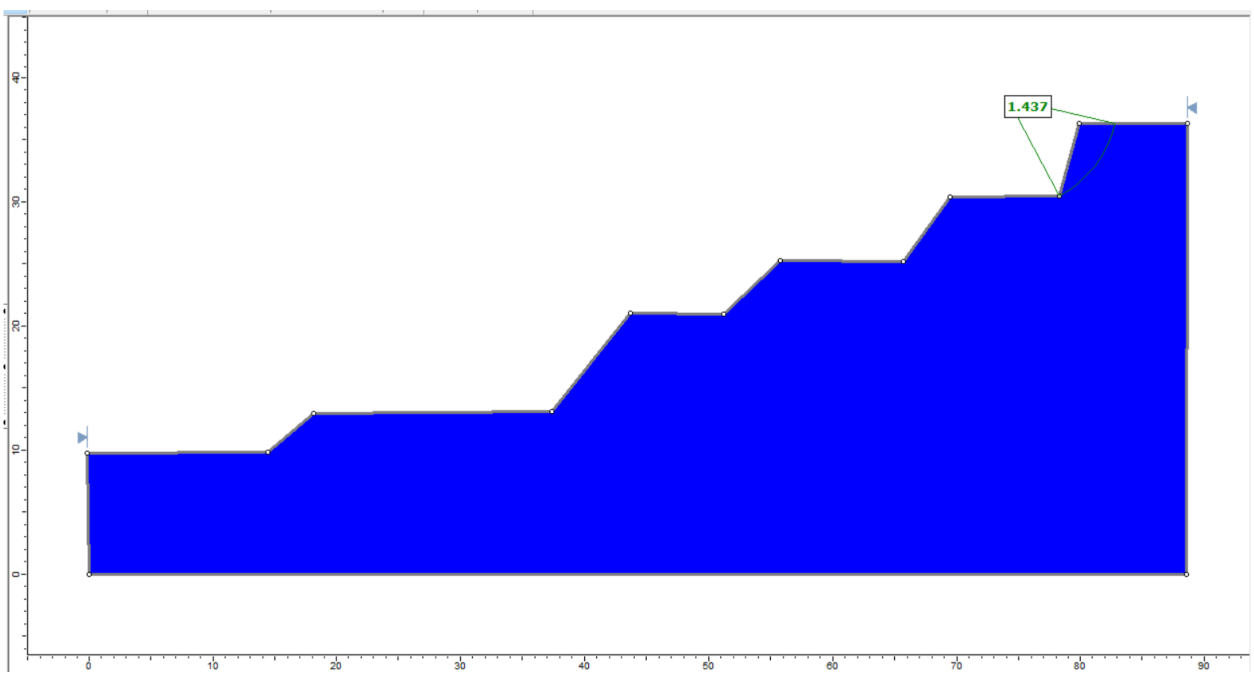


Figure 38 Slope stability analysis of a friable ore slope having FOS of 1.437

N2430700

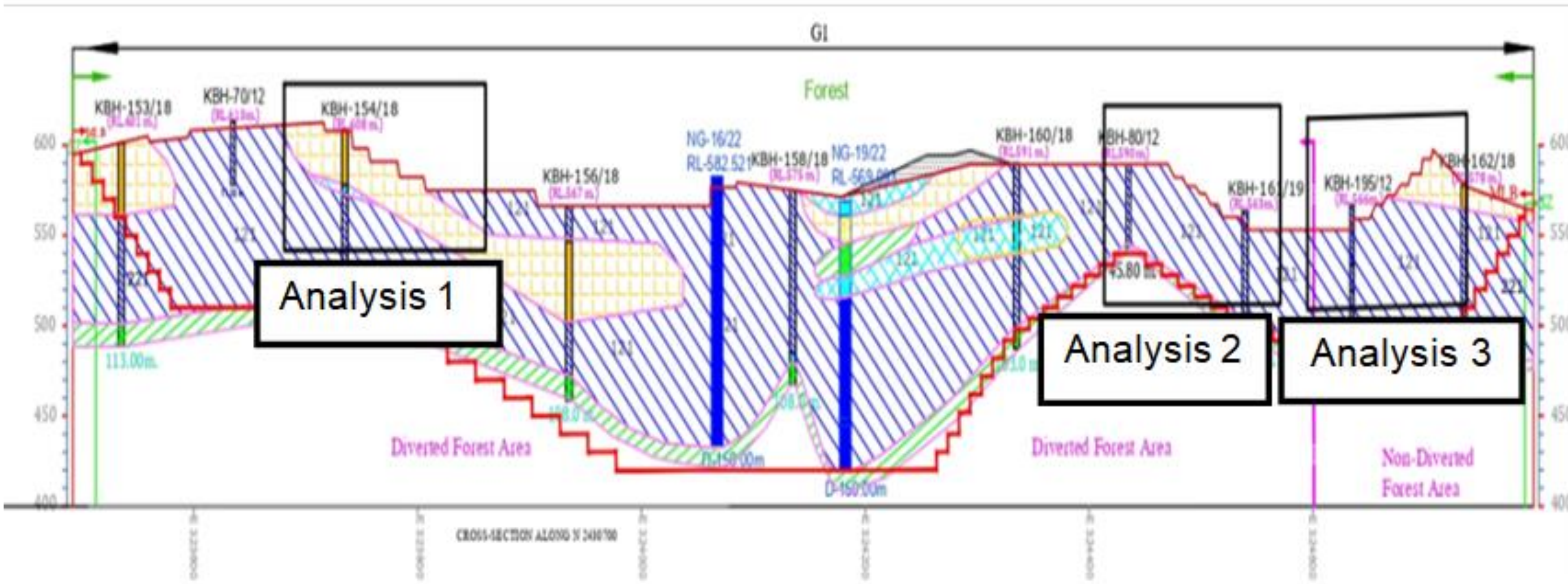
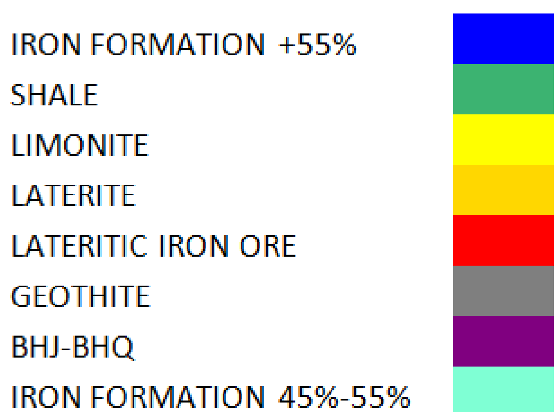


Figure 39 Nuagaon cross section N2430700



Analysis 1 - E323800

1.1 DRY CONDITION [in-situ]

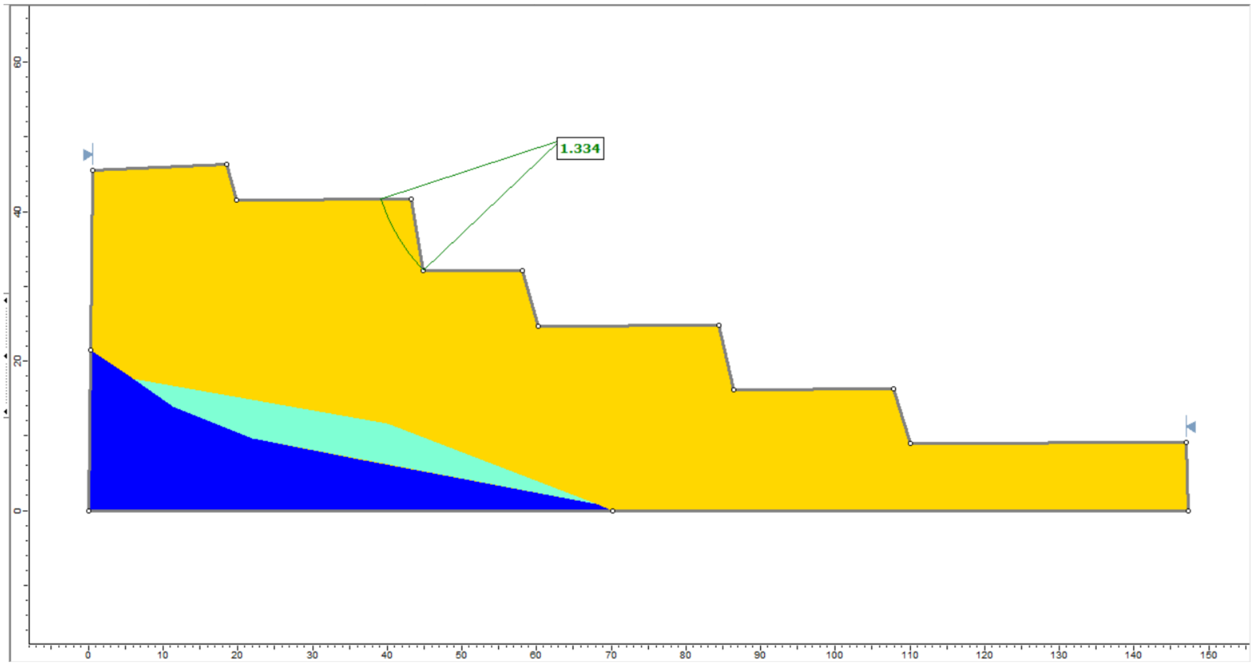


Figure 40 Slope stability analysis of a laterite slope having FOS of 1.334

1.2 SATURATED CONDITION

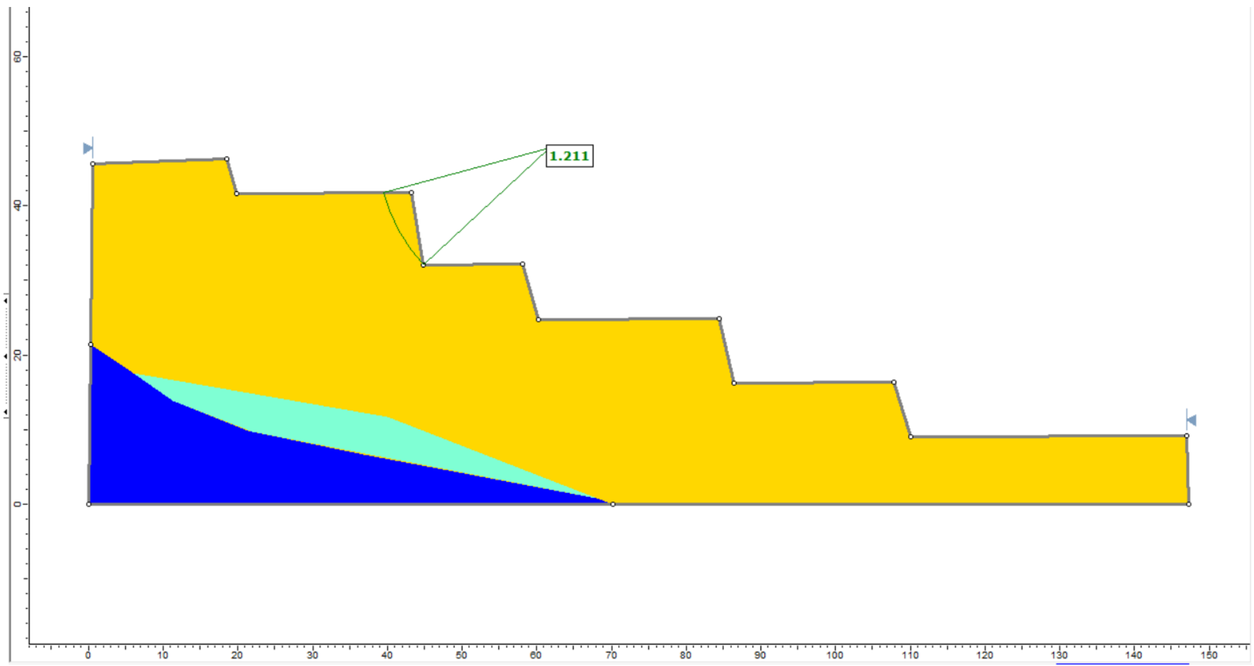


Figure 41 Slope stability analysis of a laterite slope having FOS of 1.211

Analysis 2-E324400

2.1 DRY CONDITION [in-situ]

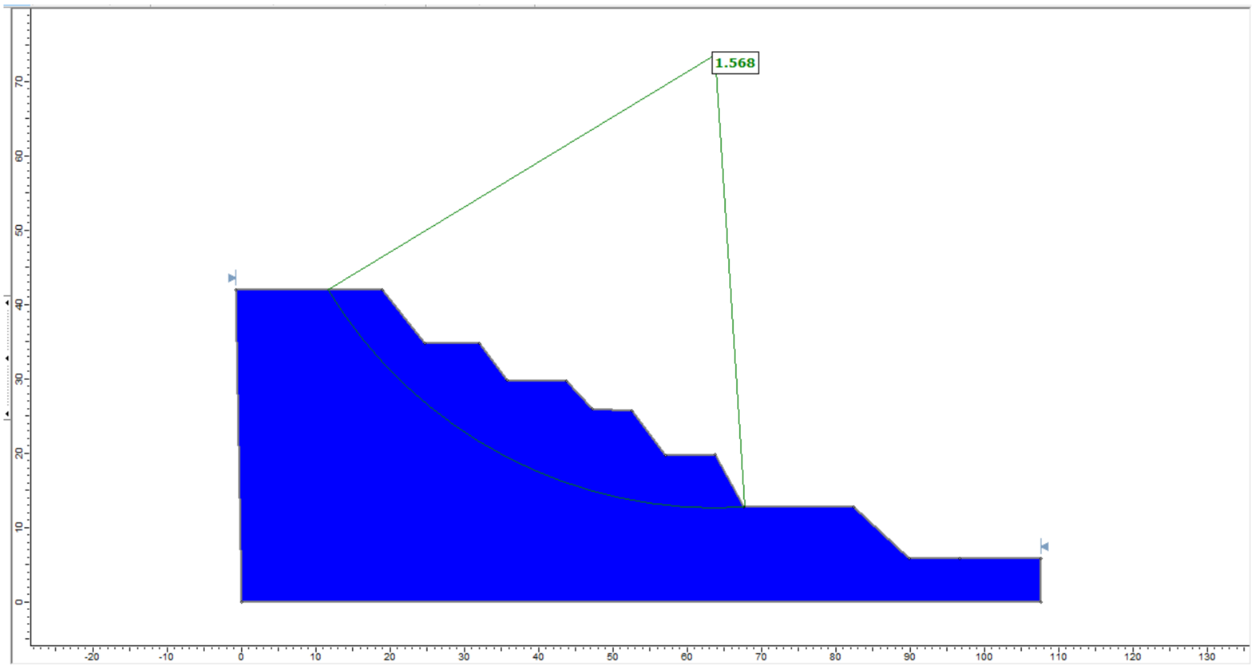


Figure 42 Slope stability analysis of a friable ore slope having FOS of 1.568

2.2 SATURATED CONDITION

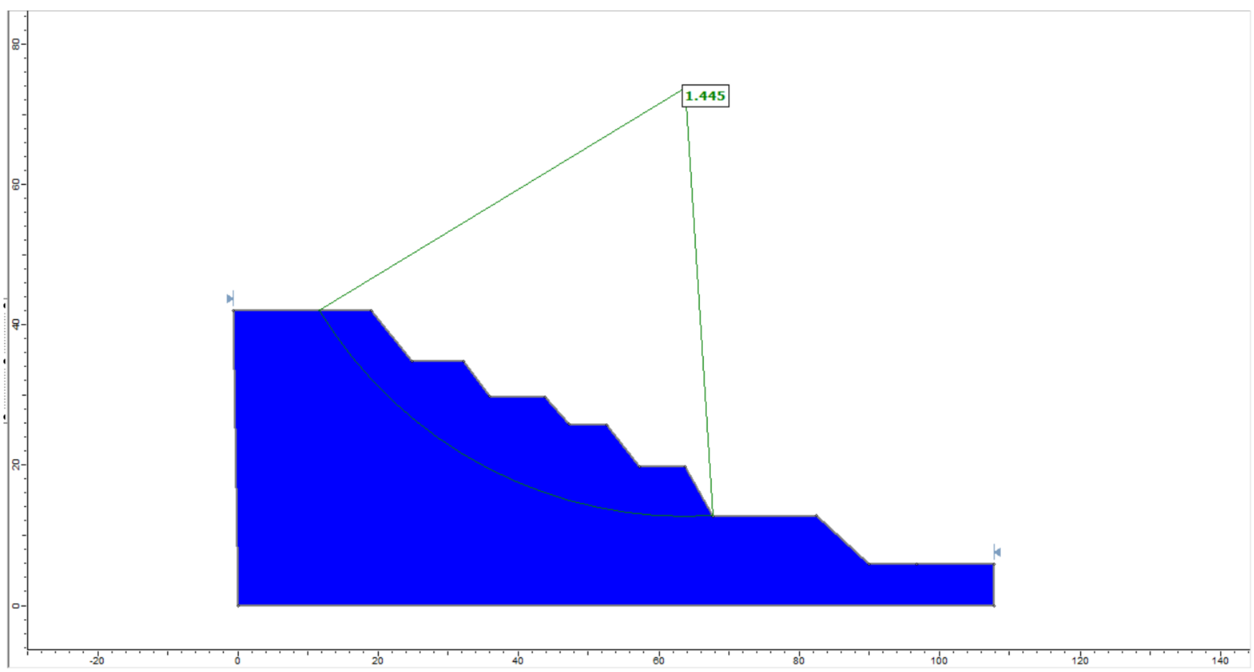


Figure 43 Slope stability analysis of a friable ore slope having FOS of 1.445

Analysis 3 - E324600

3.1 DRY CONDITION [in-situ]

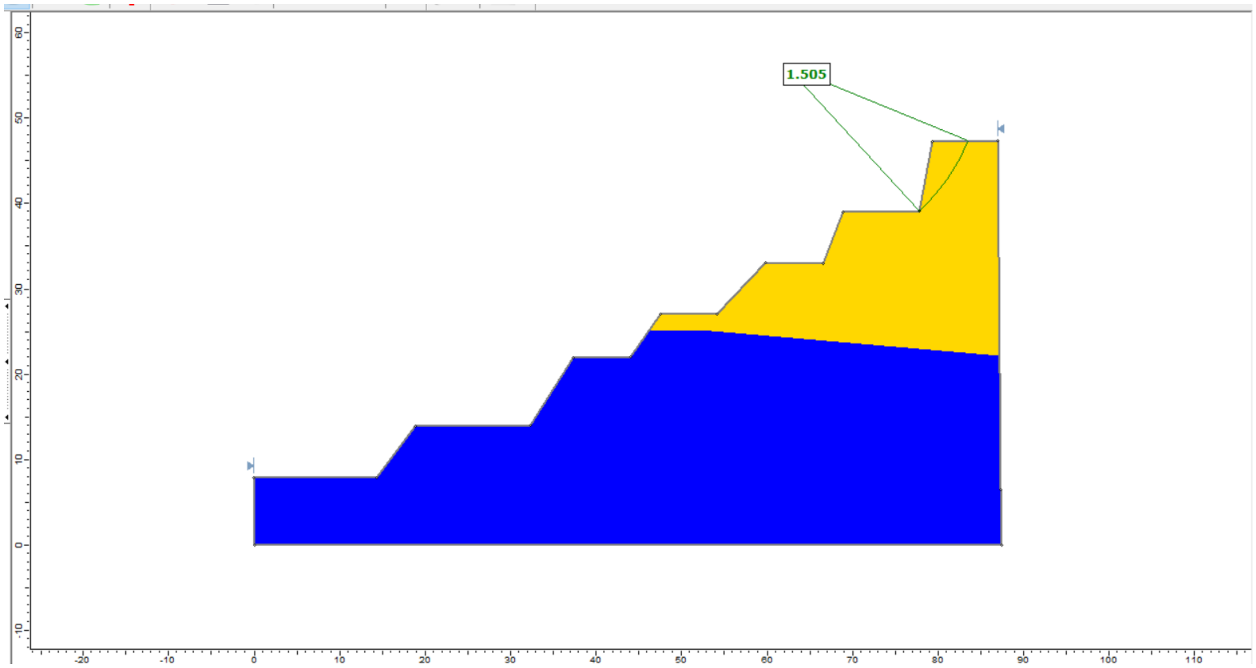


Figure 44 Slope stability analysis of a laterite slope having FOS of 1.505

3.2 SATURATED CONDITION

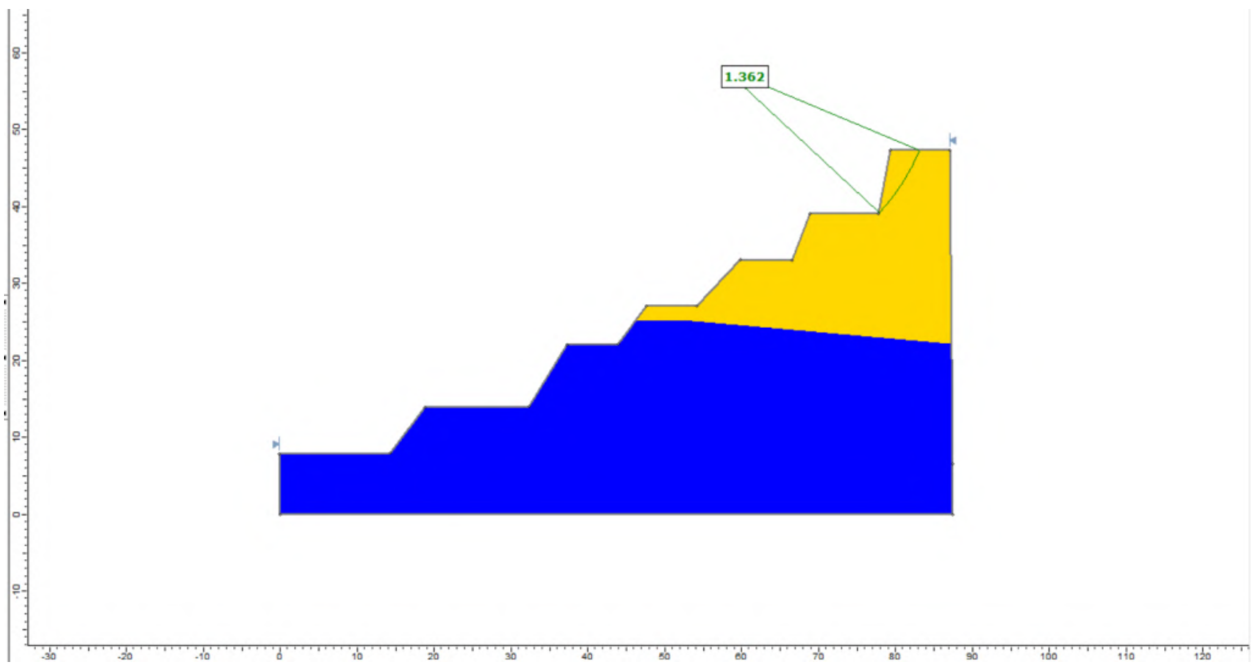


Figure 45 Slope stability analysis of a laterite slope having FOS of 1.362

SONUKUCHA QUARRY

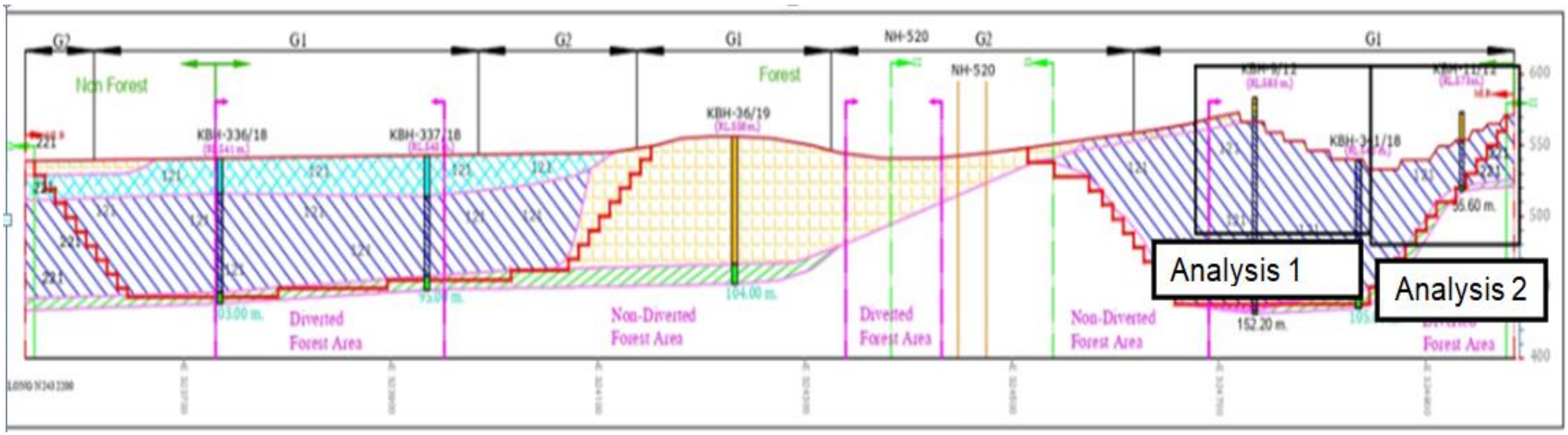


Figure 46 Nuagaon cross-section N2432200

IRON FORMATION +55%

SHALE

LIMONITE

LATERITE

LATERITIC IRON ORE

GEOTHITE

BHJ-BHQ

IRON FORMATION 45%-55%

Analysis 1 -E324700

1.1 DRY CONDITION [in-situ]

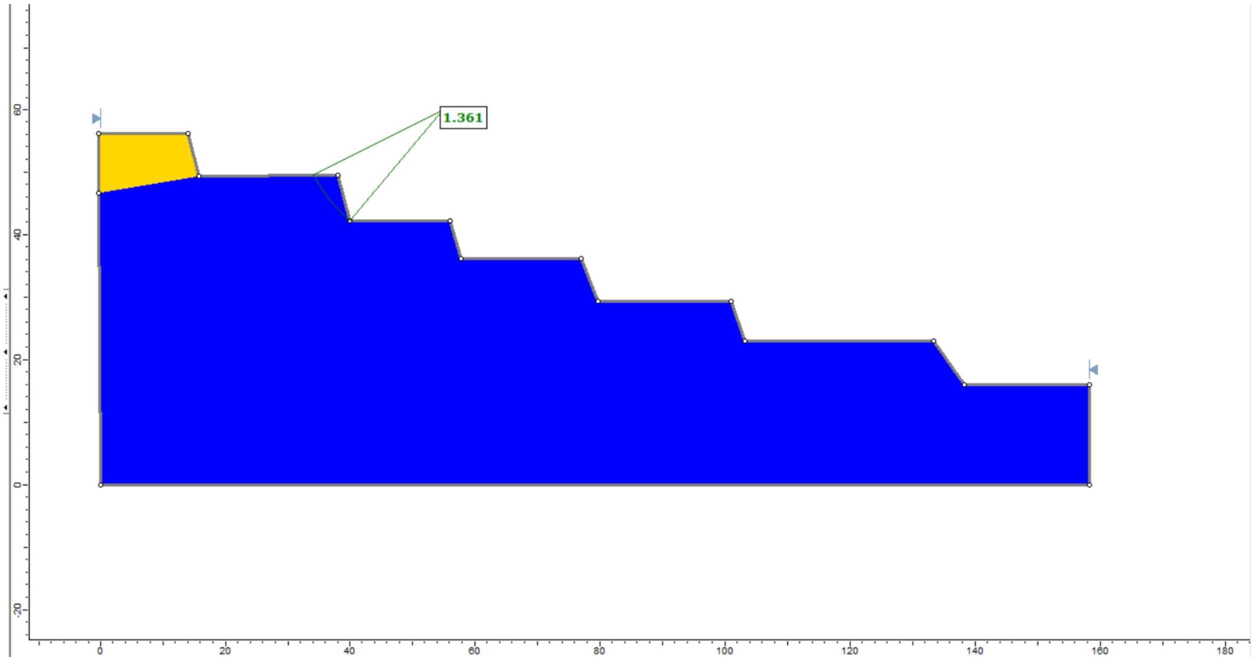


Figure 47 Slope stability analysis of a laterite slope having FOS of 1.361

1.2 SATURATED CONDITION

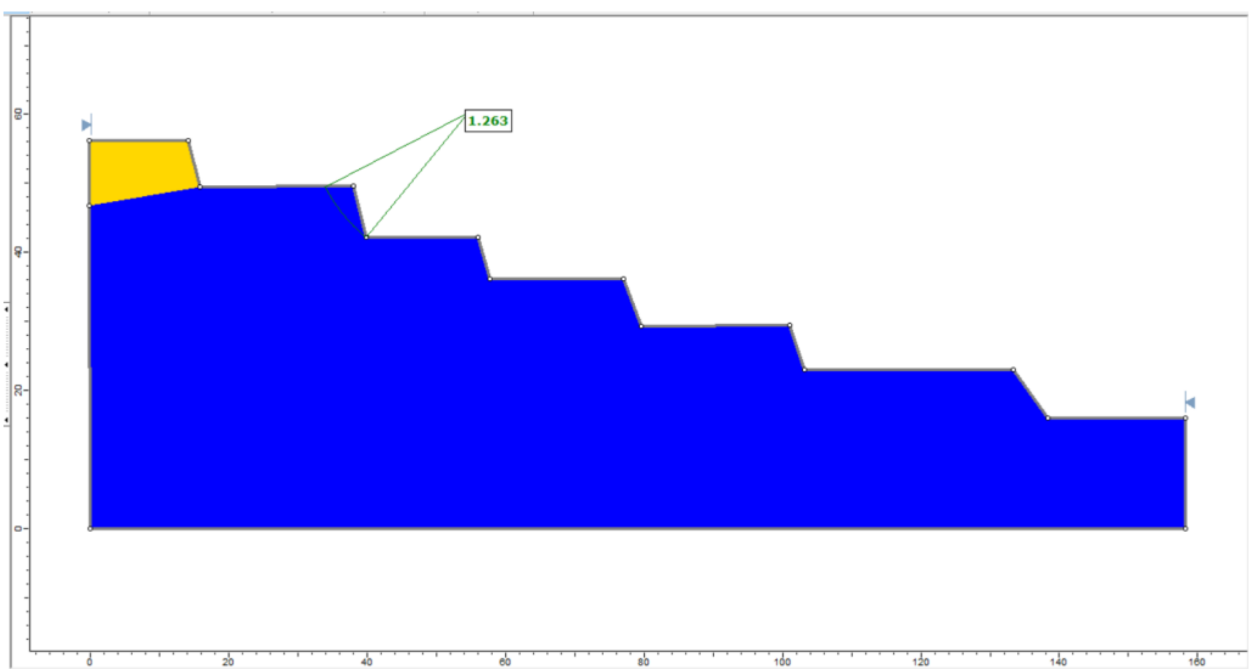


Figure 48 Slope stability analysis of a friable ore slope having FOS of 1.263

Analysis 2 -E324900

2.1 DRY CONDITION [in-situ]

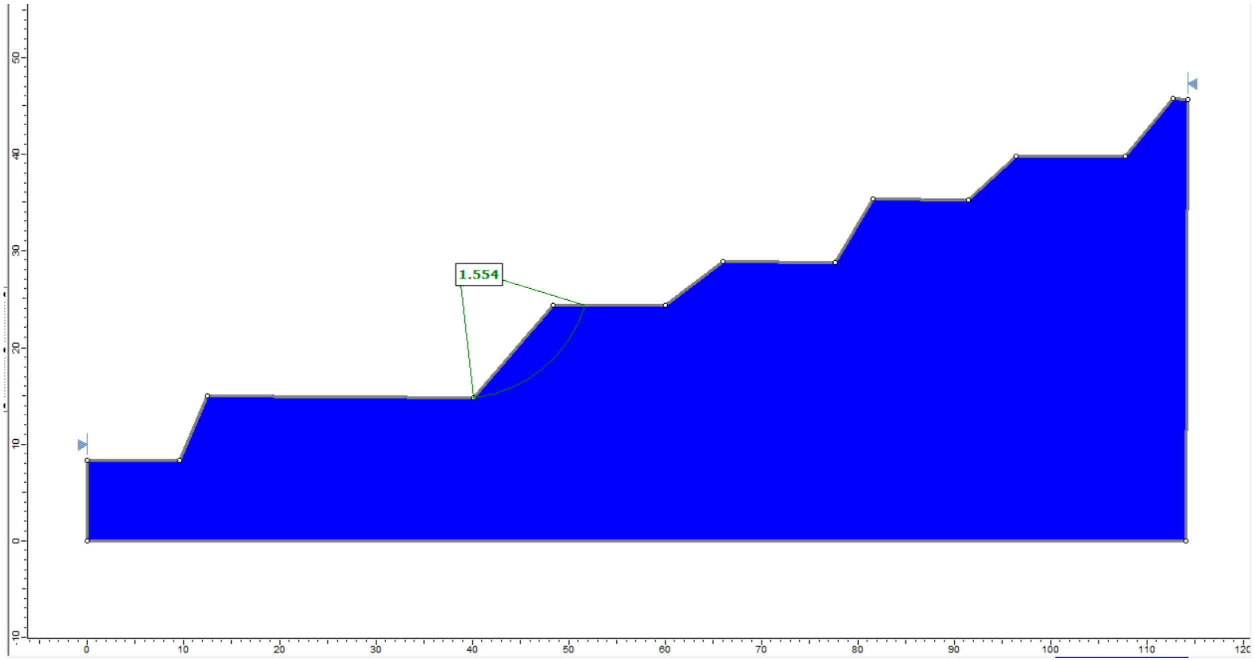


Figure 49 Slope stability analysis of a friable ore slope having FOS of 1.554

2.2 SATURATED CONDITION

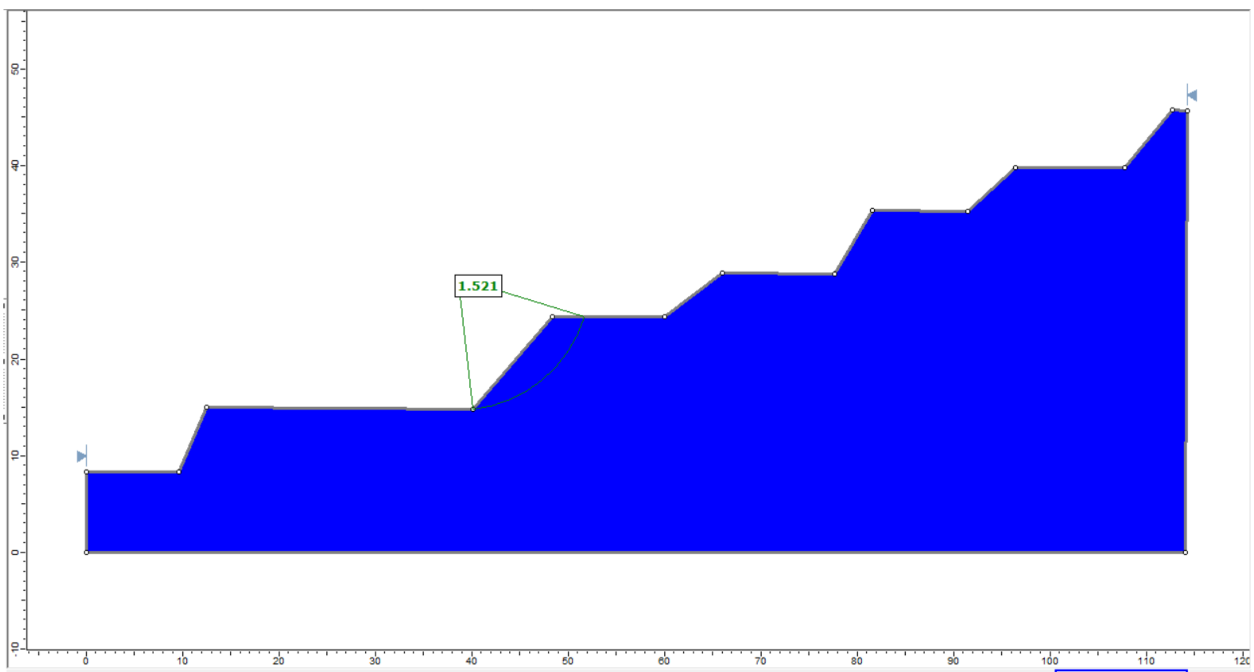


Figure 50 Slope stability analysis of a friable ore slope having FOS of 1.521

N2432100

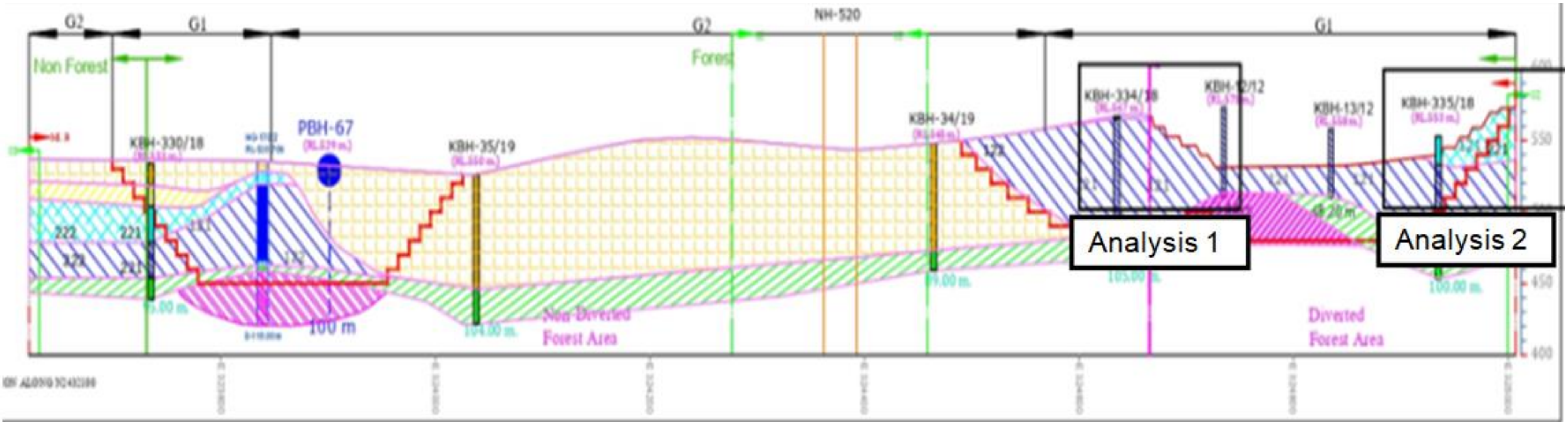


Figure 51 Nuagaon cross section N2432100

IRON FORMATION +55%
SHALE
LIMONITE
LATERITE
LATERITIC IRON ORE
GEOTHITE
BHJ-BHQ
IRON FORMATION 45%-55%

Analysis 1- E324600

1.1 DRY CONDITION [in-situ]

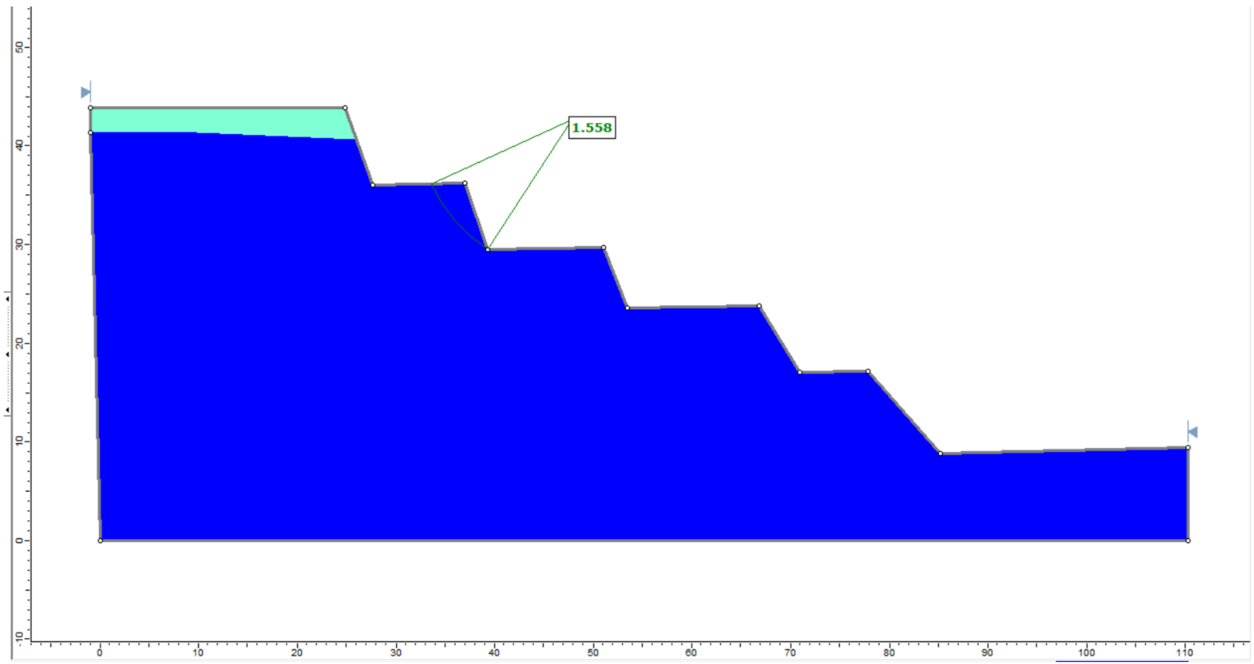


Figure 52 Slope stability analysis of a friable ore slope having FOS of 1.558

1.2 SATURATED CONDITION

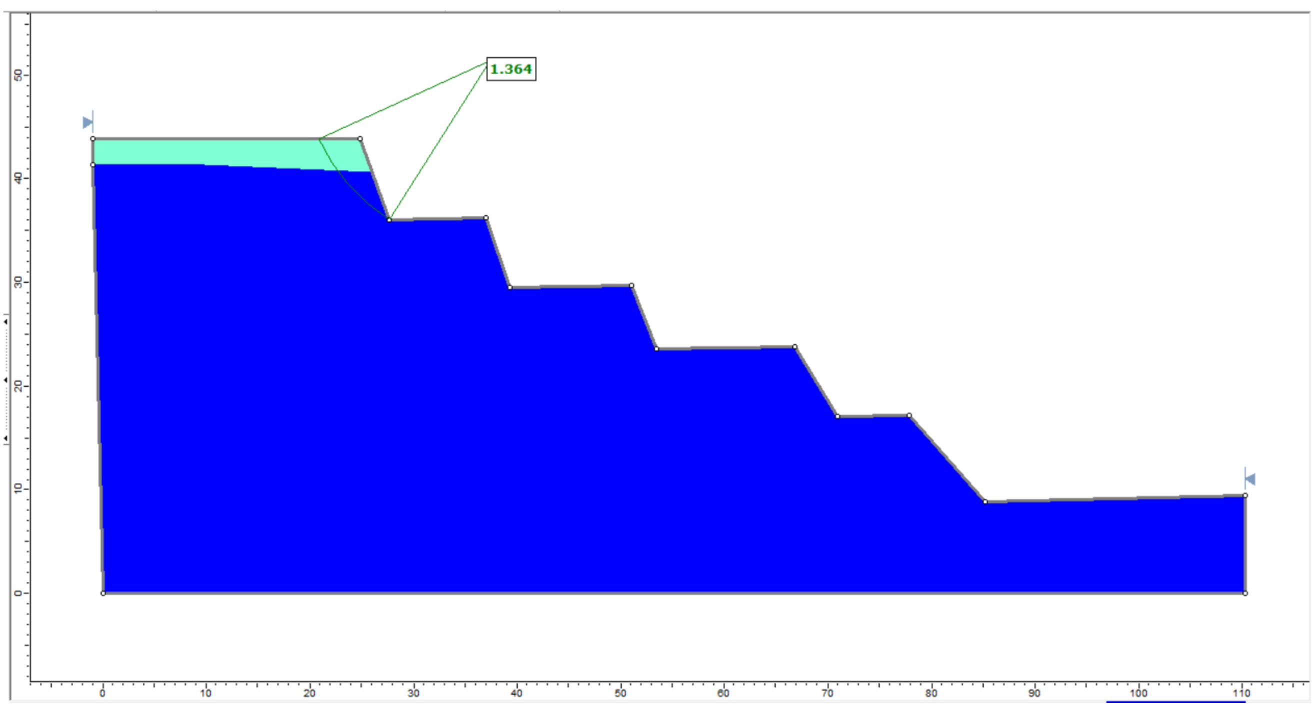


Figure 53 Slope stability analysis of a friable ore slope having FOS of 1.364

Analysis 2- E3325000

2.1 DRY CONDITION [in-situ]

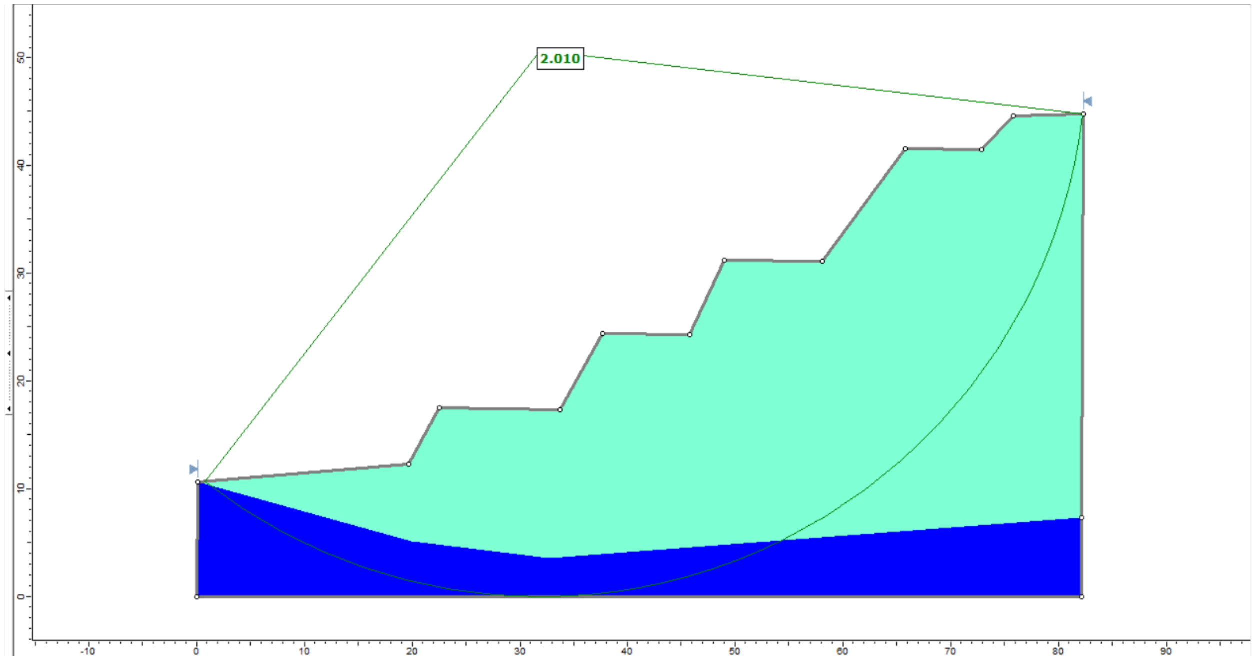


Figure 54 Slope stability analysis of a friable ore slope having FOS of 2.010

2.2 SATURATED CONDITION

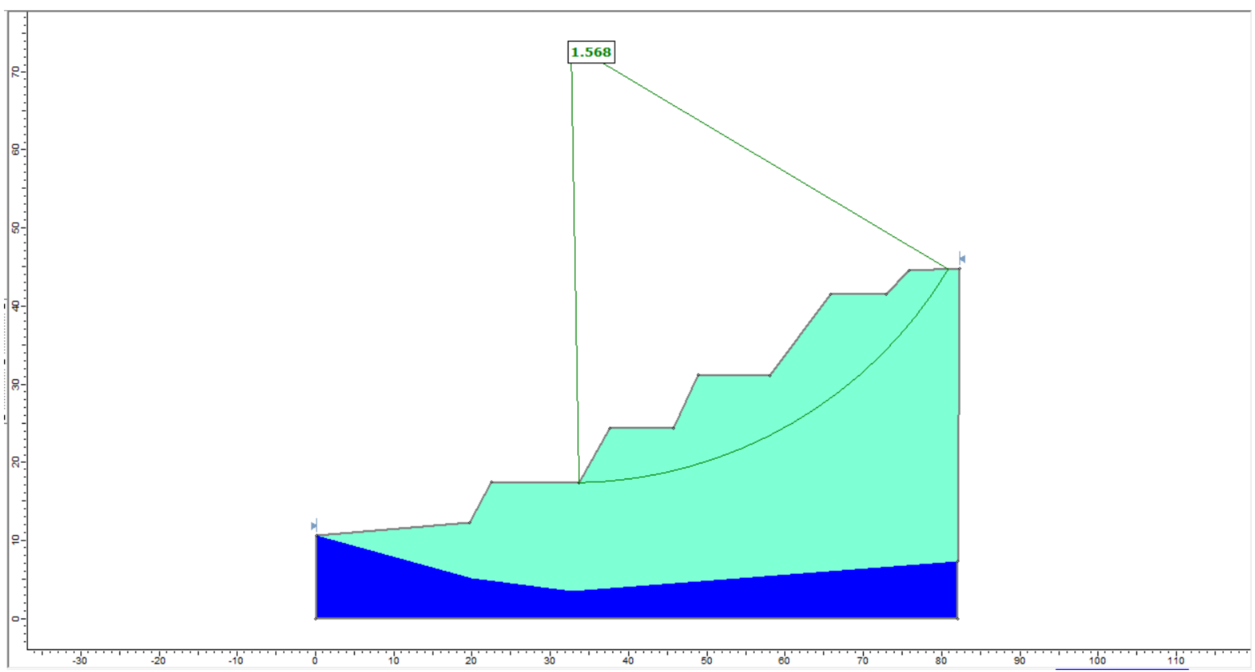


Figure 55 Slope stability analysis of a friable ore slope having FOS of 1.568

N2432000

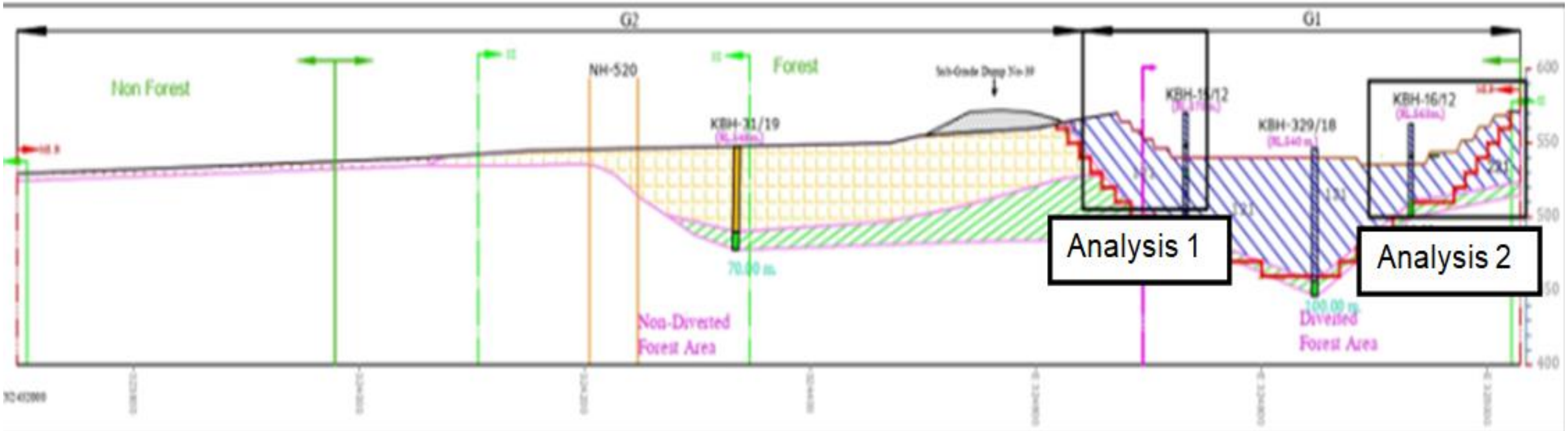


Figure 56 Nuagaon cross section 2432000

IRON FORMATION +55%

SHALE

LIMONITE

LATERITE

LATERITIC IRON ORE

GEOTHITE

BHJ-BHQ

IRON FORMATION 45%-55%

Analysis 1-E324600

1.1 DRY CONDITION [in-situ]

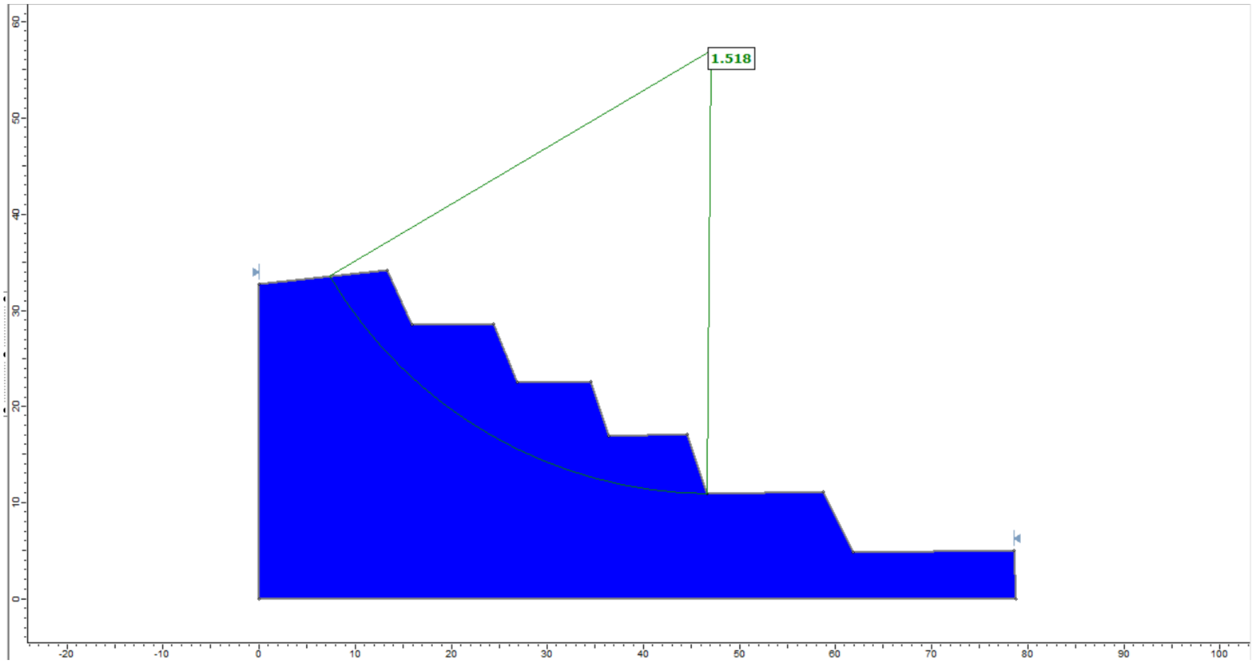


Figure 57 Slope stability analysis of a friable ore slope having FOS of 1.518

2.1 SATURATED CONDITION

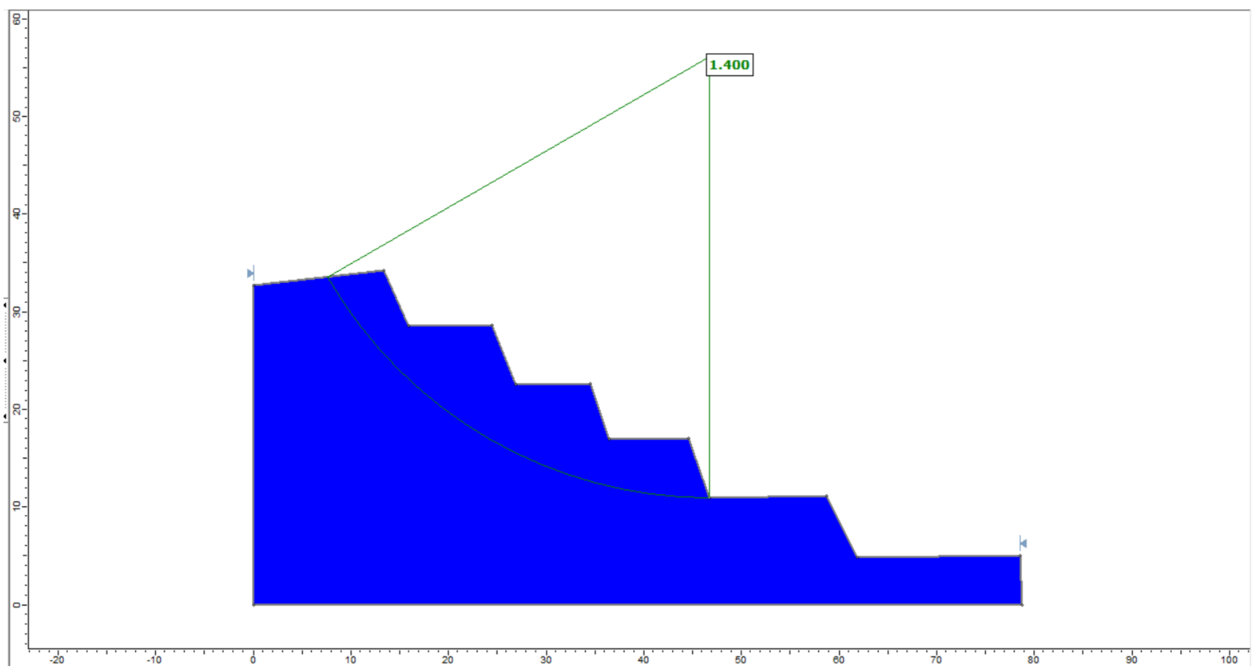


Figure 58 Slope stability analysis of a friable ore slope having FOS of 1.4

Analysis 2-E325000

2.1 DRY CONDITION [in-situ]

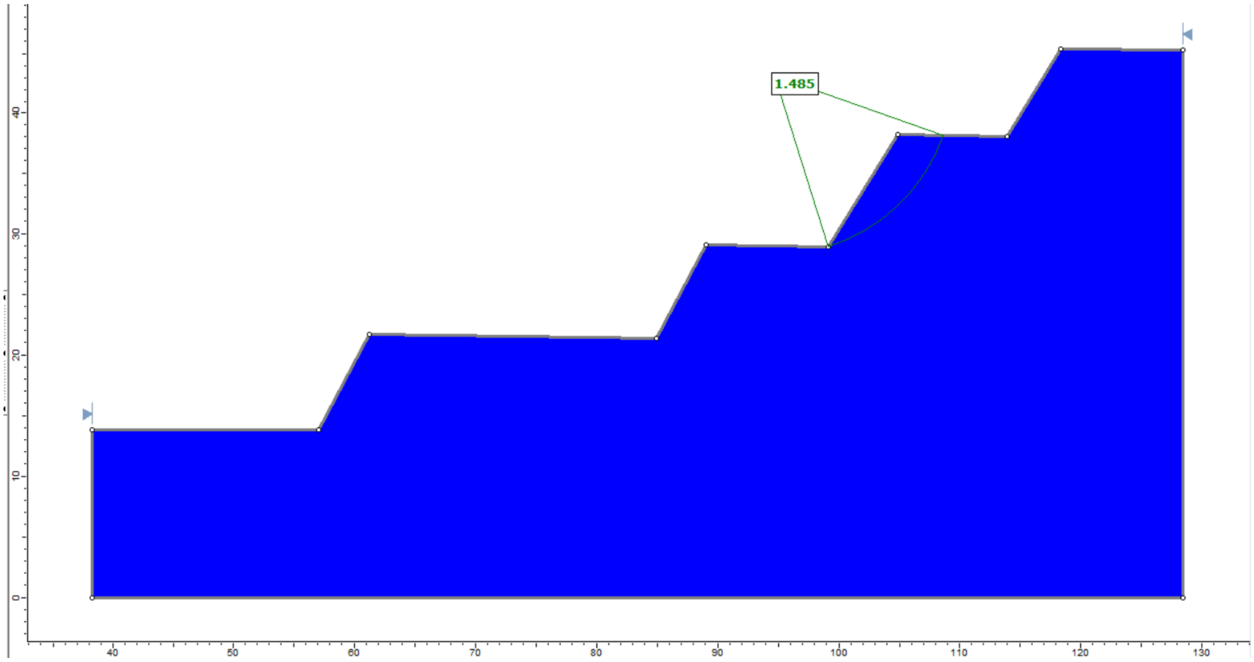


Figure 59 Slope stability analysis of a friable ore slope having FOS of 1.485

2.2 SATURATED CONDITION

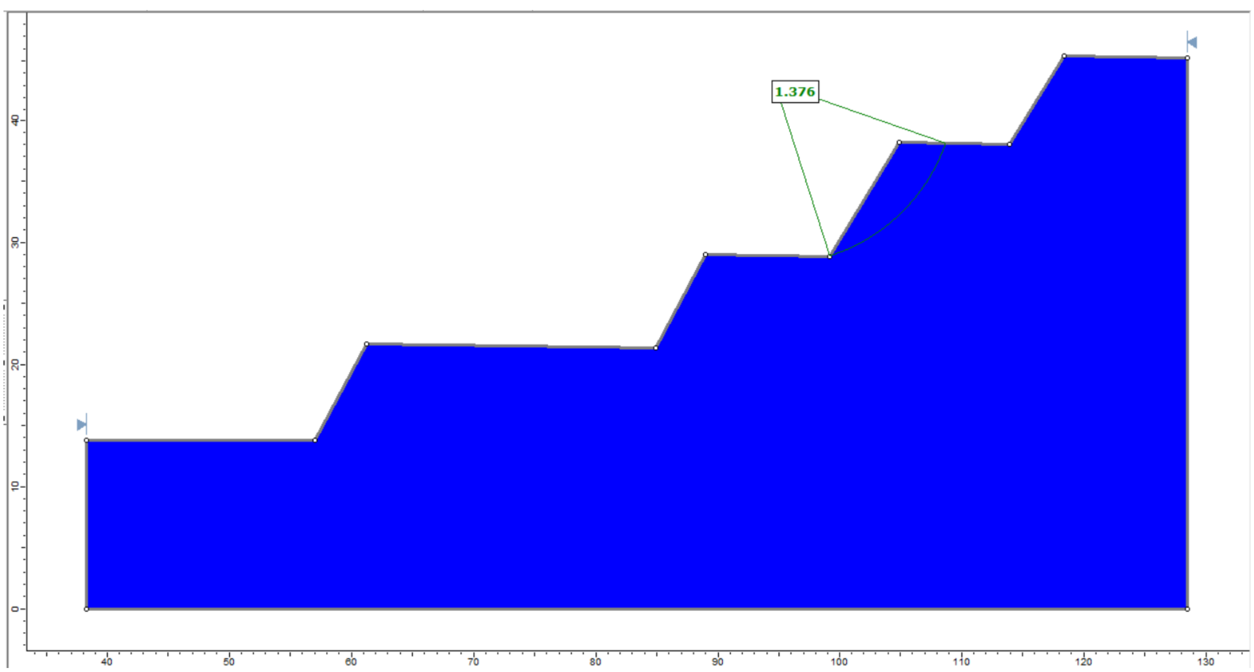


Figure 60 Slope stability analysis of a friable ore slope having FOS of 1.376

N2431900

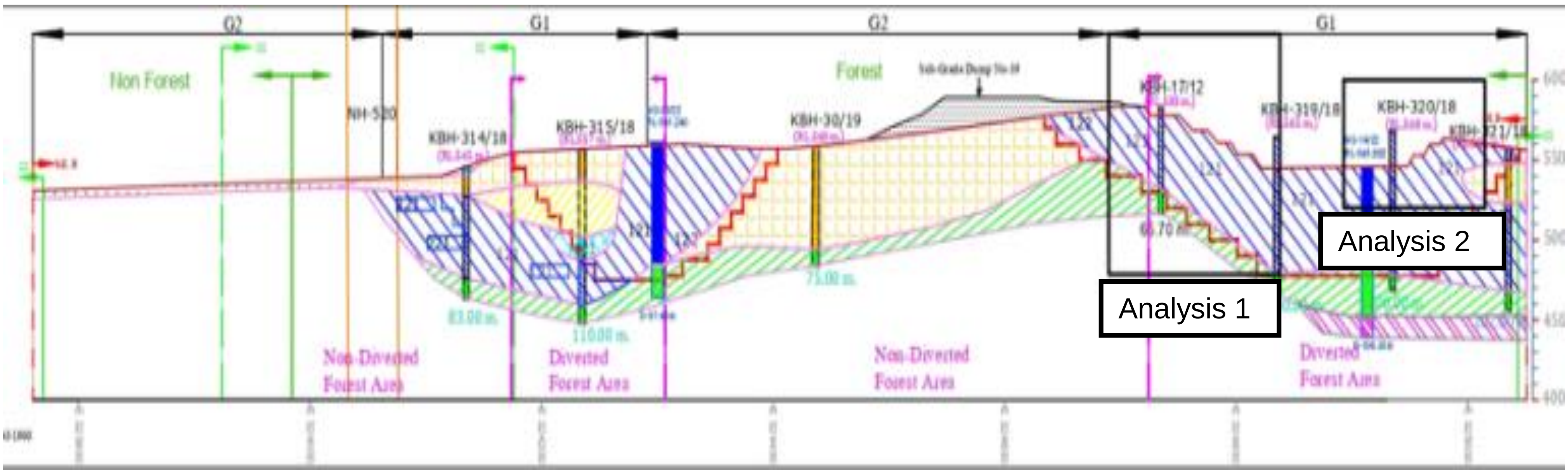


Figure 61 Nuagaon cross section 2431900

IRON FORMATION +55%
SHALE
LIMONITE
LATERITE
LATERITIC IRON ORE
GEOTHITE
BHJ-BHQ
IRON FORMATION 45%-55%

Analysis 1-E324800

1.1 DRY CONDITION [in-situ]

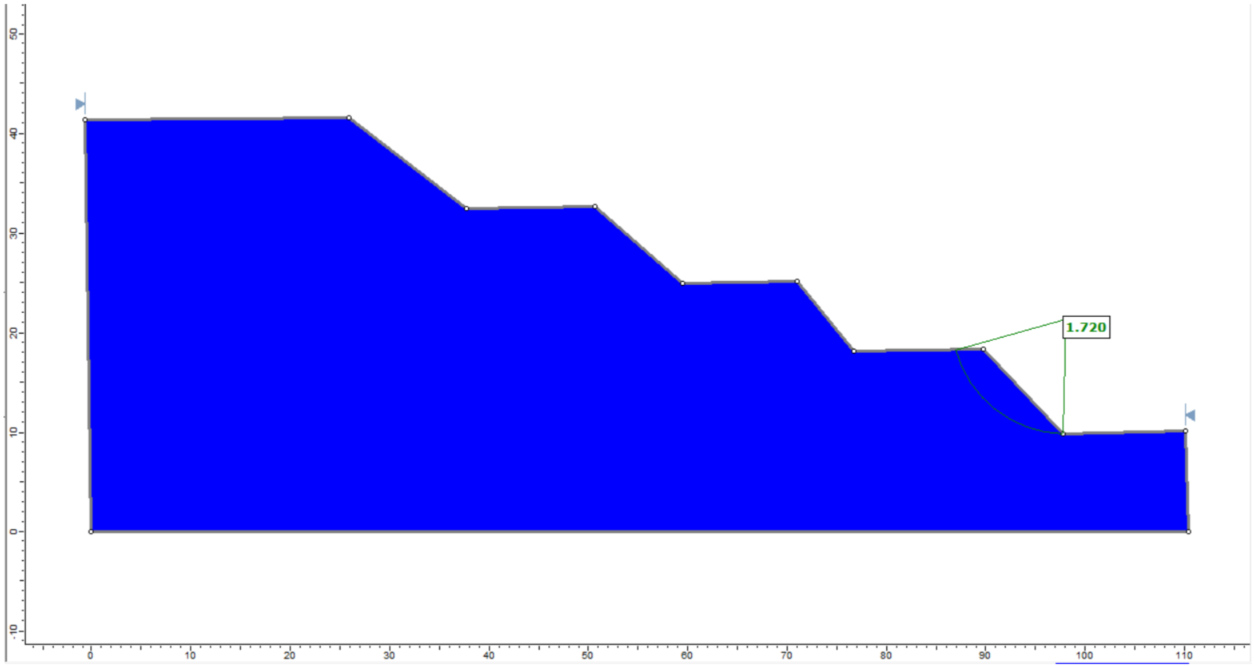


Figure 62 Slope stability analysis of a friable ore slope having FOS of 1.720

2.1 SATURATED CONDITION

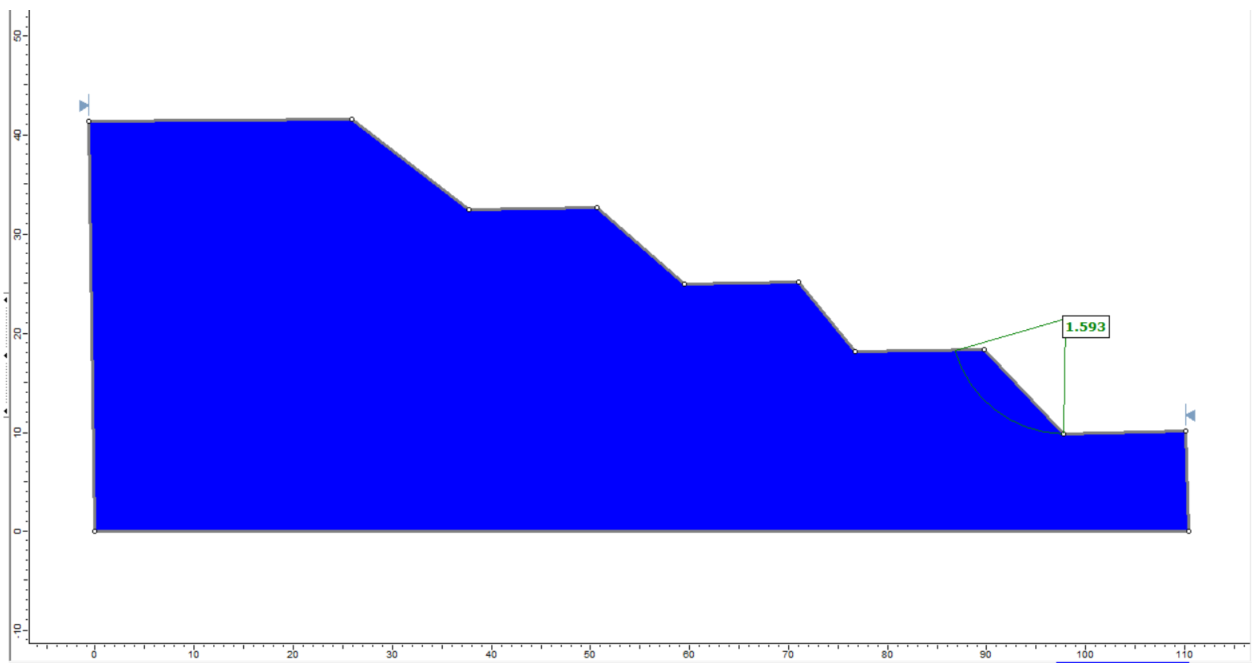


Figure 63 Slope stability analysis of a friable ore slope having FOS of 1.593

Analysis 2- E325000

2.1 DRY CONDITION [in-situ]

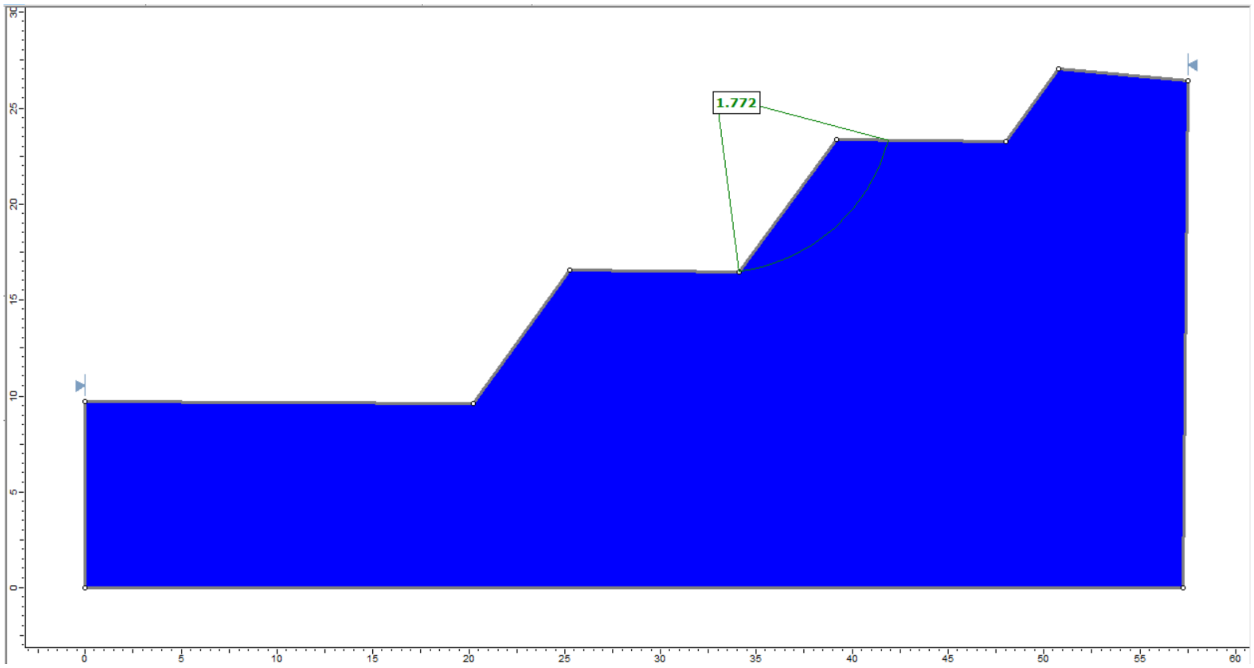


Figure 64 Slope stability analysis of a friable ore slope having FOS of 1.772

2.2 SATURATED CONDITION

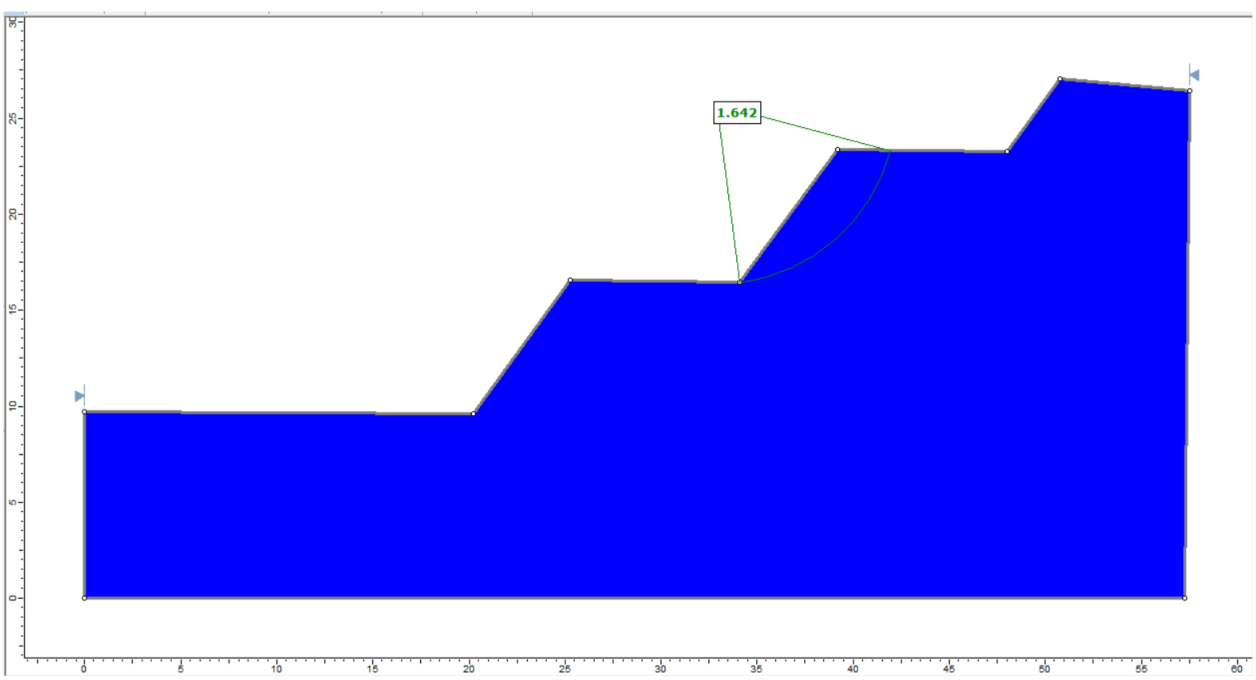


Figure 65 Slope stability analysis of a friable ore slope having FOS of 1.642

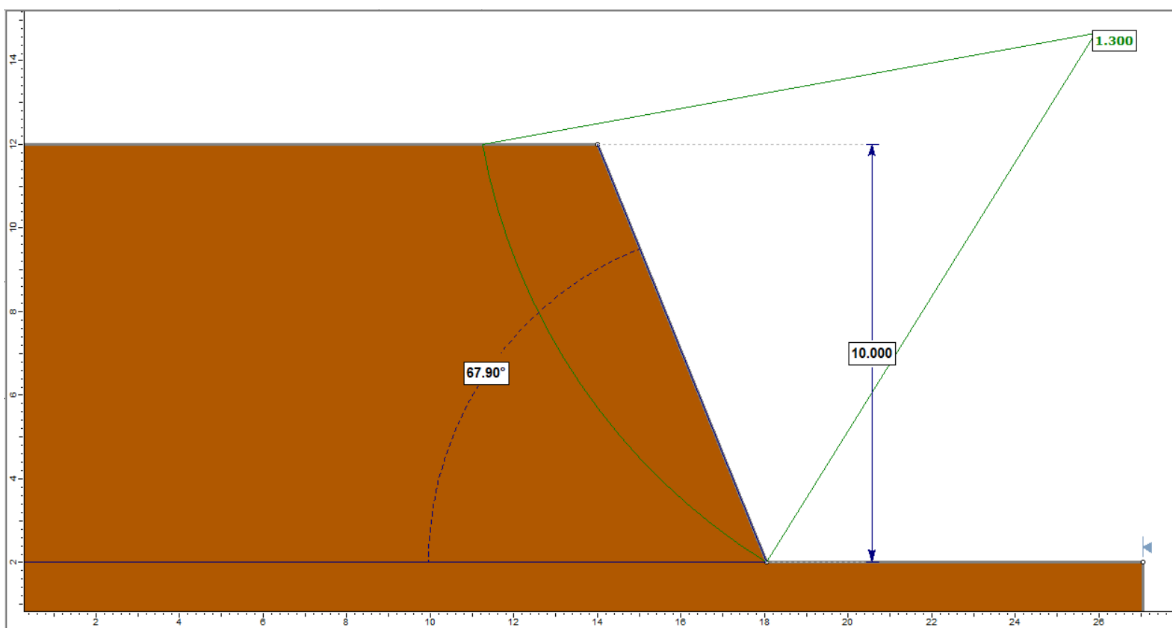
Sections	Analysis No.	FOS	failure material	Figure No.
N2430200	1.1 Dry condition	0.853	Iron Ore > 55 **%**	2
	1.2 Saturated condition	0.790	Iron Ore > 55 **%**	3
	2.1 Dry condition	1.384	Laterite	4
	2.2 Saturated condition	1.362	Iron Ore > 55 **%**	5
N2430100	1.1 Dry condition	1.258	Iron Ore > 55 **%**	7
	1.2 Saturated condition	1.194	Iron Ore > 55 **%**	8
	2.1 Dry condition	1.255	Iron Ore > 55 **%**	9
	2.2 Saturated condition	1.146	Iron Ore > 55 **%**	10
N2430000	1.1 Dry condition	1.415	Iron Ore > 55 **%**	12
	1.2 Saturated condition	1.368	Iron Ore > 55 **%**	13
N2429900	1.1 Dry condition	1.859	Laterite + Iron Ore 45-55 **%** + Iron Ore > 55 **%**	15
	1.2 Saturated condition	1.596	Laterite + Iron Ore 45-55 **%** + Iron Ore > 55 **%**	16
N2429800	1.1 Dry condition	3.351	Iron Ore 45-55 **%**	18
	1.2 Saturated condition	2.130	Iron Ore 45-55 **%**	19
N2429000	1.1 Dry condition	1.933	Iron Ore > 55 **%**	21
	1.2 Saturated condition	1.804	Iron Ore > 55 **%**	22
N2428800	1.1 Dry condition	1.488	Iron Ore > 55 **%**	24
	1.2 Saturated condition	1.467	Iron Ore > 55 **%**	25
N2430900	1.1 Dry condition	1.639	Iron Ore > 55 **%**	27
	1.2 Saturated condition	1.520	Iron Ore > 55 **%**	28
N2423800	1.1 Dry condition	1.206	Iron Ore > 55 **%**	30
	1.2 Saturated condition	1.118	Iron Ore > 55 **%**	31
N2430800	1.1 Dry condition	1.375	Laterite	33
	1.2 Saturated condition	1.262	Laterite	34
	2.1 Dry condition	1.539	Iron Ore > 55 **%**	35

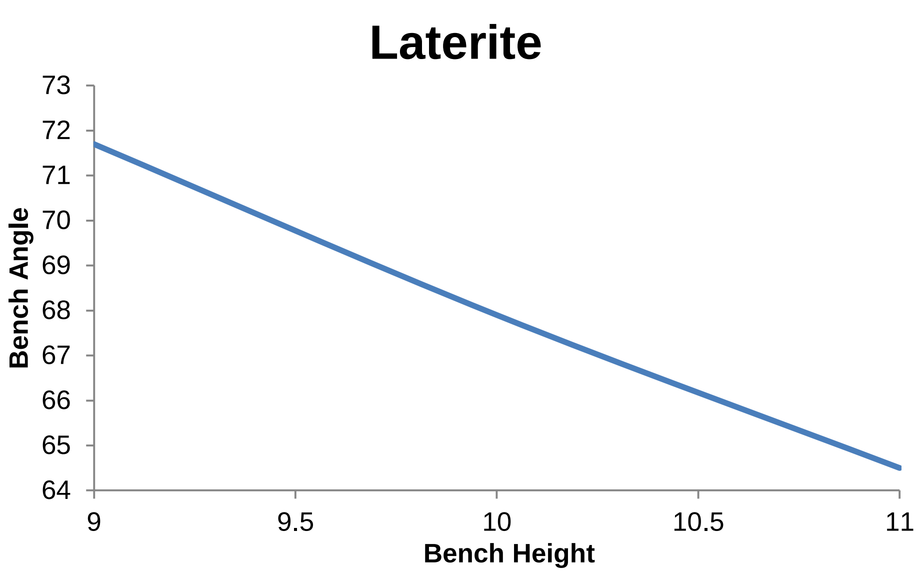
	2.2 Saturated condition	1.418	Iron Ore > 55 %	36
	3.1 Dry condition	1.548	Iron Ore > 55 %	37
	3.2 Saturated condition	1.437	Iron Ore > 55 %	38
N2430700	1.1 Dry condition	1.334	Laterite	40
	1.2 Saturated condition	1.221	Laterite	41
	2.1 Dry condition	1.568	Iron Ore > 55 %	42
	2.2 Saturated condition	1.445	Iron Ore > 55 %	43
	3.1 Dry condition	1.505	Laterite	44
	3.2 Saturated condition	1.362	Laterite	45
N2432200	1.1 Dry condition	1.361	Laterite	47
	1.2 Saturated condition	1.263	Iron Ore > 55 %	48
	2.1 Dry condition	1.554	Iron Ore > 55 %	49
	2.2 Saturated condition	1.521	Iron Ore > 55 %	50
N2432100	1.1 Dry condition	1.558	Iron Ore > 55 %	52
	1.2 Saturated condition	1.364	Iron Ore 45-55 %	53
	2.1 Dry condition	2.010	Iron Ore 45-55 %	54
	2.2 Saturated condition	1.568	Iron Ore 45-55 %	55
N2432000	1.1 Dry condition	1.518	Iron Ore > 55 %	57
	1.2 Saturated condition	1.4	Iron Ore > 55 %	58
	2.1 Dry condition	1.485	Iron Ore > 55 %	59
	2.2 Saturated condition	1.376	Iron Ore > 55 %	60
N2431900	1.1 Dry condition	1.720	Iron Ore > 55 %	62
	1.2 Saturated condition	1.593	Iron Ore > 55 %	63
	2.1 Dry condition	1.772	Iron Ore > 55 %	64
	2.2 Saturated condition	1.642	Iron Ore > 55 %	65

RECOMMENDATIONS

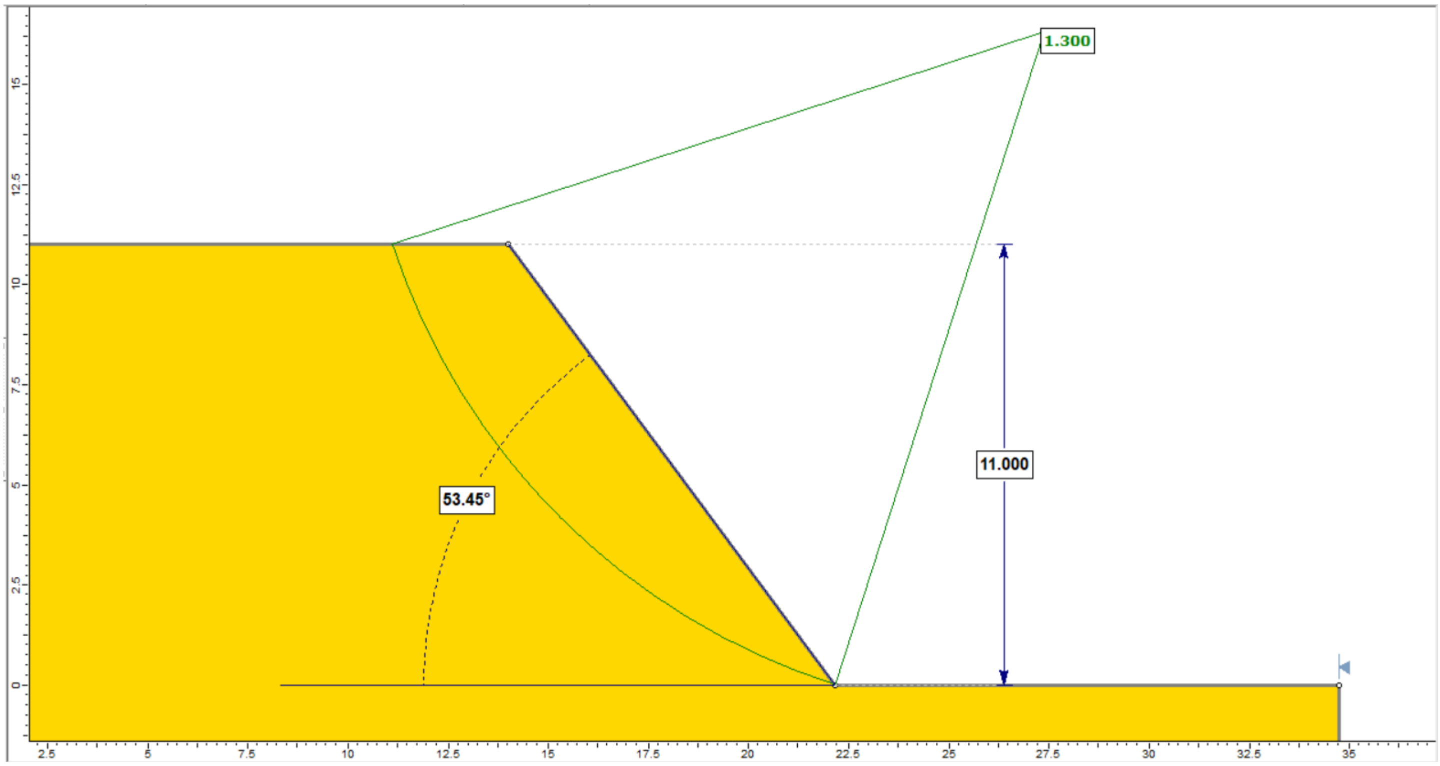
The objective is to find the ideal bench parameters for probable failure material profiles. Models were designed and analyzed to achieve optimum bench dimensions for the specific material profile. The characteristic Models with a constant bench height having a safety factor of 1.3 are shown below with their corresponding slope angles. Additionally, graphs were attached to showcase a relation between optimum bench parameters and FOS. With the help of the trend line, the optimal bench angle corresponding to the existing bench height to attain a safety factor of 1.3 can be determined.

LATERITE

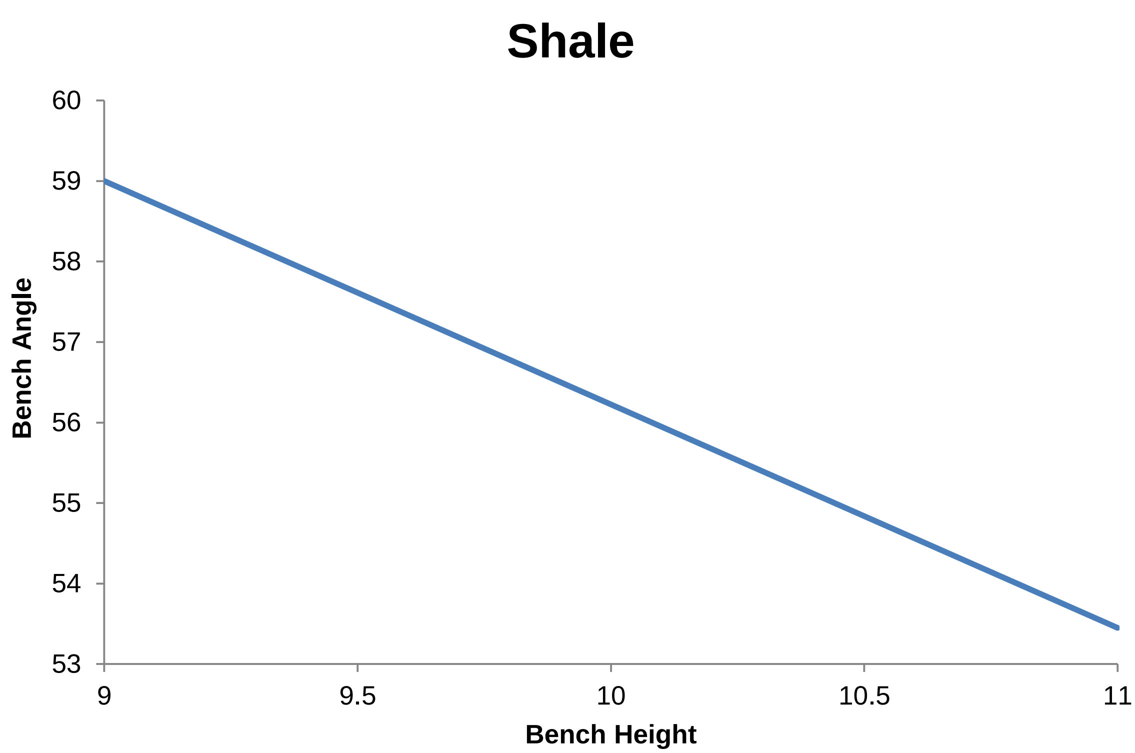




SHALE

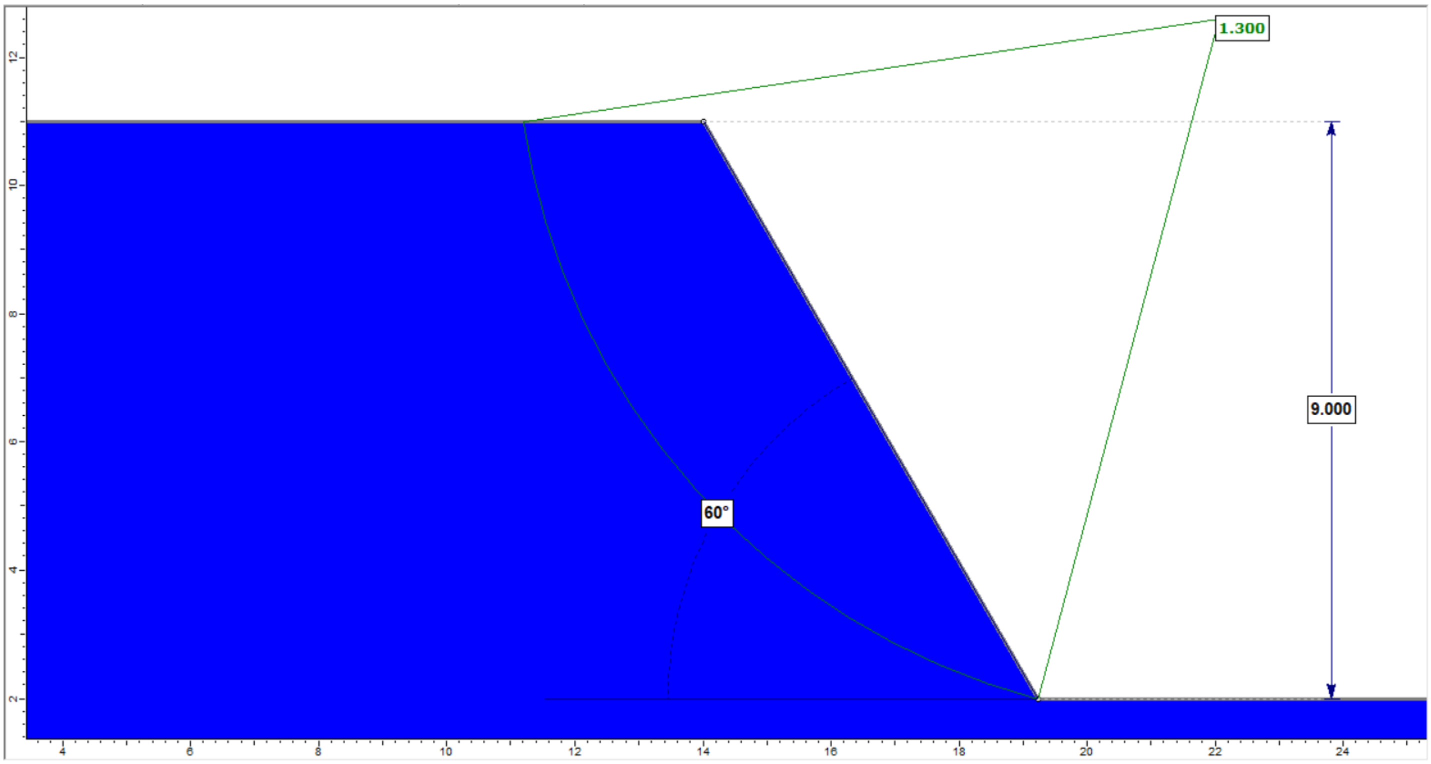


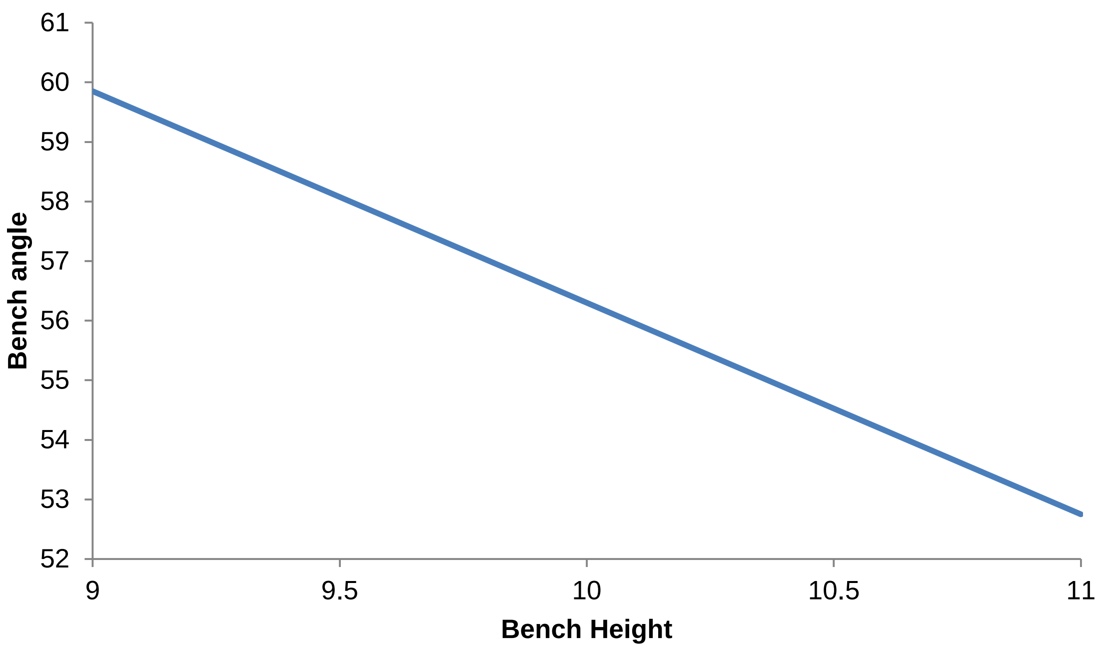
1.300
11.000
53.45°
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
27.5
30
32.5
35
0
2.5
5
7.5
10
12.5
15



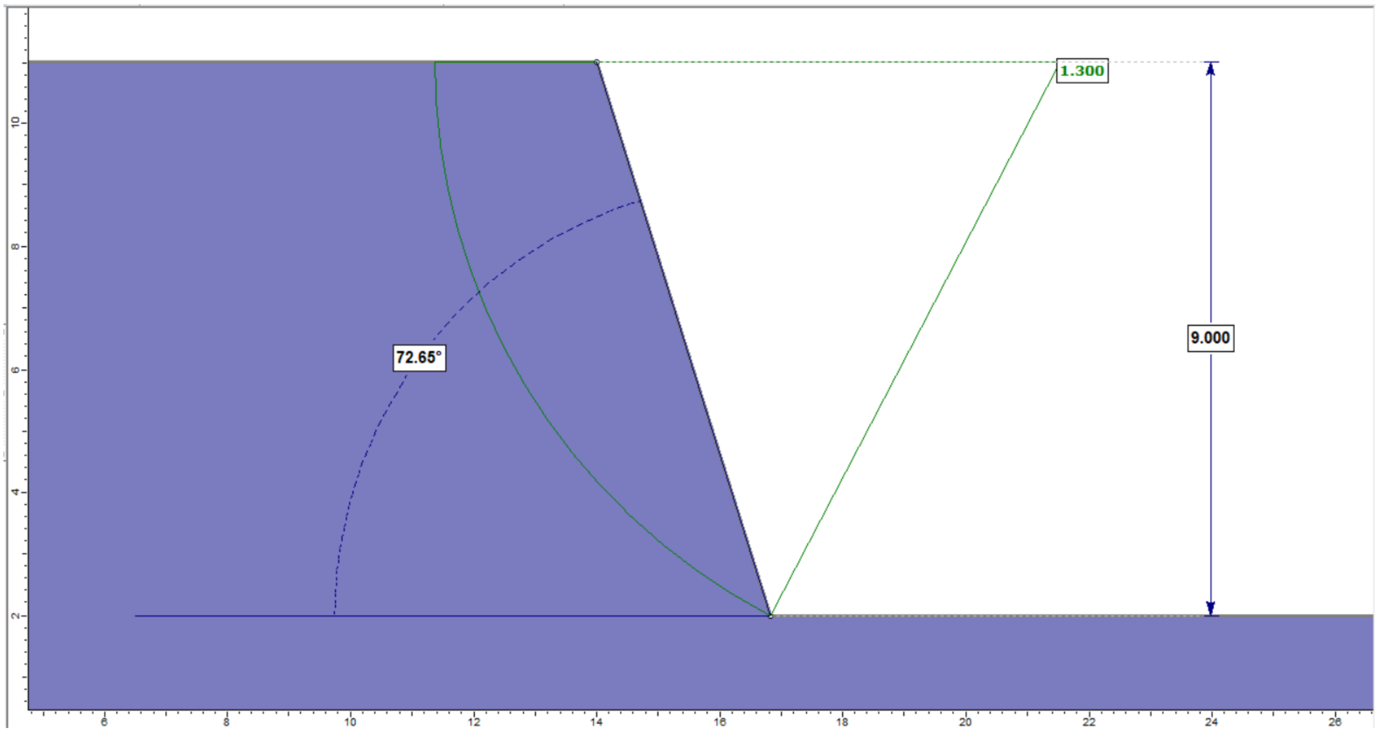
Shale
Bench Angle
60
59
58
57
56
55
54
53
9
9.5
10
10.5
11
Bench Height

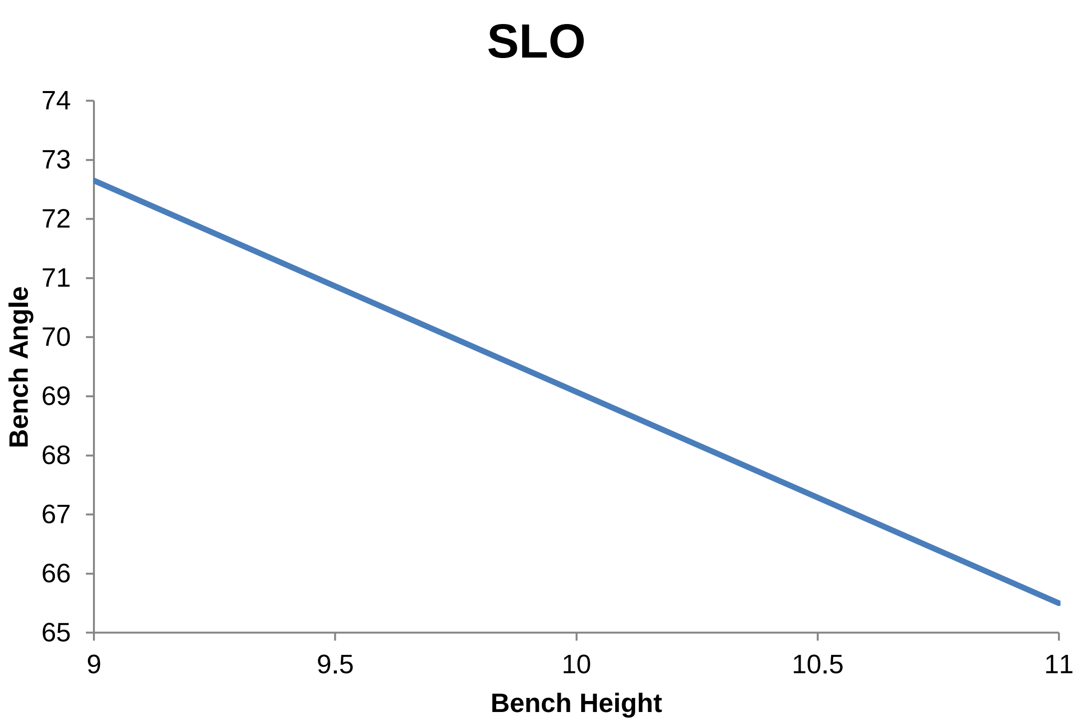
BLUE DUST


1.300
9.000
60°
12
10
8
6
4
2
4
6
8
10
12
14
16
18
20
22
24


Blue Dust
Bench angle
61
60
59
58
57
56
55
54
53
52
9
9.5
10
10.5
11
Bench Height

SLO





Precautionary Measures

Unanticipated movement on the ground can pose hazardous condition that may harm lives, equipment and properties. There are several ways to reduce chances of surface ground failure as (a) safe geotechnical design, (b) secondary support or rock fall catchment system, and (c) maintaining devices for advance warning of impending failure. Proper bench design can minimize rock fall hazards. Certain support system may enhance overall rock mass strength. The analysis shows that no large scale failure is possible thoughlocalised bench failure cannot be ruled out. Those should be arrested by lower benches and hence access of machineries should be maintained.

2.1 <u>Drainage and Water Management</u>

Rainwater plays a adverse role in mine slope stability. So care should be made to avoid entry of rainwater in the slope. So, suitable drainage facility should be made in and around the mine and waste dump. Drains should be properly maintained. Drain channels should be inspected regularly to keep the path free from debruises. Effectiveness of drainage may be maintained by piezometers and other instruments to check the functioning.

Rainwater should not be allowed to accumulate or left unattended. Effective garland drain should be provided around pit and waste dumps. Maintaining a proper gradient should help in quick run off of water. Surface run off and sub surface water adds to instability.

Grasses have very high binding capacity and help in long term stabilization. It also helps in reducing the water pressure due to evapo-transmission.

2.2 <u>Water management</u>

Rainwater of the adjacent areas should not be allowed to enter the mine pit. It would cause erosion and deep gullies. So rainwater catchment area should be channeled away to other areas. The upper surface of the mine and dump should be adequately graded to divert he run off of rain water away. Therefore, proper levelling and grading of surface should be carried out. Regular and continuous maintaining should be done to check the flow path of rainwater and to take immediate remedial measures. Rainwater in the dump should be channel down effectively through effective toe drain arrangement. Subsurface drainage system or sub drains should remove subsurface water directly from an unstable slope, to redirect adjacent ground water sources away and to reduce hydrostatic pressure.

2.3 Stability of Benches

Pit walls often experience vibration due to poor blasting operations. Uncontrolled blasting results in over brakes, widening of existing cracks/joints, creation of fresh cracks etc. Those become critical to the stability of pit slopes. Therefore, a properly designed and controlled blasting should be carried out. Controlled blasting with closely spaced or carefully designed drill holes, properly selected explosives, and sequential detonation should be adopted. The control blasting can be achieved by broadly by (i) using an explosive with a relatively low detonation velocity, and (ii) maintaining air gap between the explosive and the wall of drill hole. The mine authority is recommended to go for scientific study for this.

2.4 Slope Monitoring

Three general principles of slope geo-mechanics that govern slope stability are (Kliché, 1999)

a. Slope failures do not occur spontaneously
b. Most slope failures tend towards equilibrium
c. A slope failure does not occur without warning

The slope should be regularly monitored to observe any instability in advance so as to avoid any damage to men and machineries. The instability if detected at early stage can be addressed by adopting suitable remedial measure. In general, slope stabilization involves continuous monitoring of the slopes to detect any movement. The guidelines given in the gazette of Indian extraordinary part –II, section 3, Subsection-1, New Delhi Feb 21, 2020 for mine workings should be followed. There should be a team of dedicated skilled persons with proper training for slope monitoring exercises. Slope stabilization schemes as grading, serrating, benching, arresting rock falls, and other measures should be adopted. Slope monitoring mechanism varies widely from a simple visual observation of signs of instability to use of state of art instrumentation. Regular surveying of other benches and their movement both horizontal and vertical can be carried out to determine potential instability. Determination of simple displacement by tension cracks mapping, extensometers and survey points are some of the cost effective monitoring method. Typically, all these methods should be adopted as no single method represent the whole behavior accurately. Systematic mapping of tension cracks show geometry of the failure more effectively. All cracks should be mapped regardless of apparent cause. The end of the cracks should be flagged or marked so that new cracks or extensions of existing cracks can be identified. Portable wire extensometers provide monitoring in areas of active instability across tension cracks. The extensometers should be positioned on stable ground behind the last visible tension crack and the wire should extend to the unstable area. Anyone working in the area can check on slope movement by inspecting the instruments. The monitoring of prism targets with the total station provide detailed movement history for displacement and rates in the unstable areas.

2.5 Monitoring Schedule

A well designed and developed monitoring schedule should be established. Frequency of monitoring depends on precision, rate of movement and how critical the area is. If there is heavy rain or a large blast in the area, additional measurement should be made. Mines should attempt to establish measurement of surface movement through survey network. The network should consist of target areas/locations/sections (e.g. prism shape) placed on and around area of anticipated instability on slopes and one or more non-moving contact points for survey stations. The angles and distances from the survey stations to the locations/areas/sections should be measured on regular basis to establish history of movement on slope. The permanent control points for the survey stations should be placed on stable ground.

2.6 Tension Cracks

The formation of cracks at the top of a slope, specifically on dump sections exhibits the sign of instability. The measurement and monitoring of the changes to crack width and its direction of propagation establish the extent of the unstable area. Existing cracks may be identified with clear identification so that new cracks can be easily identified.

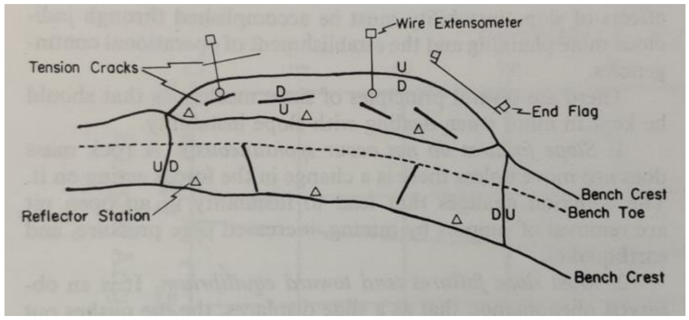


Figure 17. Methodology to measure tension crack (after Call, 1982)

Measurements of tension cracks can be carried out simply by driving two stakes or either side of it and measuring its separation over time. Portable wireline extensometer is another method of monitoring tension crack behaviour.

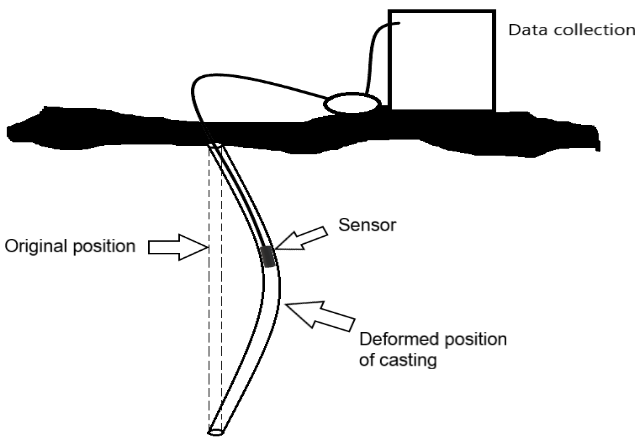


Figure 18: Cross-sectional schematic of typical traverse-probe inclinometer system

Inclinometer is another equipment to monitor ground movement specifically in horizontal direction (fig 16, pp). The end of the casing is fixed to a stable part. The groves have sensing units and the deflection of casing reflects the movement of rock mass. Inclinometers provide information on

- Location of shear zones
- Natures of shear along the zone plan rotational
- Measurement along shear zones and predict its rate i.e. constant, accelerating or decelerating

Borehole extensometer is another technique to monitor slope movement. It consists of tensioned rods anchored at varying points in the borehole (Fig 18). Changes in the distance between the anchor and the rod head give the movement information for rock mass.

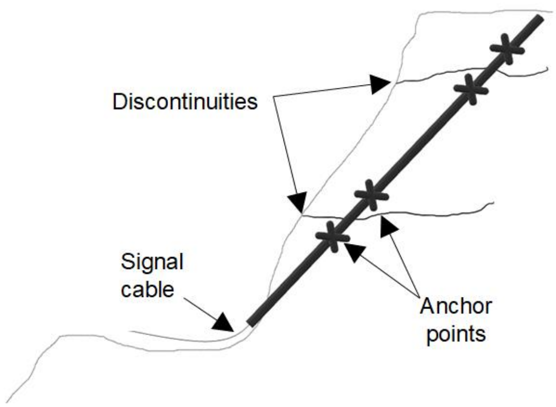


Figure 19: Multi-point borehole extensometer

TDR (Time Domain Reflectometry) is a recent approach that uses electronic pulses through coaxial cable. Signal at the deformation or break in cable position gives information on the subsurface rock mass behaviour.

2.7 Piezometers

The effectiveness of mine dewatering schemes and the effects of seasonal variations can be determined by piezometers. Excessive pore pressure, water infiltration in particular at geological boundaries cause slope failures. So data on water pressure development should be maintained regularly. Highwalls and other potential faces should be examined regularly for new seeps or changes in water flow rate.

Stress, gravity loading, rock mass strength, geology, pore pressure as well as many other factors contribute to slope failure. Complete attention to monitor each and every potential failure block is neither feasible not economical and often not attainable with conventional point displacement monitoring techniques. As mining activities progress, it becomes important to monitor different sections of the pit walls. So, frequent relocation of survey devices can be challenging. One recent advancement that is being experimented with success is synthetic aperture radar (SAR). It can generate high quality digital elevation maps (DEMs) and detect disturbances of earth's surfaces. There are a few variations of the same that are being developed that can take continuous images in almost all weather and time conditions. Those may be explored by the mine management.

3.0 Conclusions and Recommendations

The following conclusion and recommendations are made with reference to the slope stability investigation carried for Nuagaon iron ore mine.

1. There is no challenge due to ground water at the mine. However, steps are recommended to have an effective garland drain / bund all around to collect/ divert run off rain-water of the catchment area before it reaches the mine slopes. The drains should be kept clear of silt and debris.

2. There should be regular mapping of the weak zones, faults and bedding planes of the pit by geologist and data should be used for further analysis of slope stability for different geo-mining condition. It will facilitate to detect any unfavorable conditions at different stages of mining.

3. Mining and excavation activities change the physical dimension of the system. So regular scientific study should be carried out for safety factor analysis of the pit as well as dump sections, say every 5 to 6 years or if significant alteration of system happens or change in geological structural features observed.

4. Mine management should make a dedicated team of trained and competent persons for slope monitoring with clearly defined duties and responsibilities DGMS (Tech). Circular No. 2 of 2020 dated 09.01.2020. The monitoring should be done periodically at least once a month and the results of the monitoring should be recorded. The monitoring data should be regularly analyzed to predict the slope movement or instability well in advance. In case of need/ help or advice may be sought from expert agencies in the field of slope stability and slope monitoring.

5. The open cracks, whenever develop, the partially consolidated new pump mass should be consolidated with the help of dozer/ compactor followed by proper levelling of the benches so that

entry of water in cracks is minimized. It will help to consolidate the dumped material and will minimize filtration of water inside slopes.

6. During rainy season, an officer should be deputed for regular visual observation around the mine and dump to see the effectiveness of drains. If any blockage is observed, immediately steps should be taken to make it effective. If any tension crack is detected in the pit/dump, the entry of water inside the crack should be checked.

7. Recommendations stipulated in the report should be implemented in total and under the supervision of a competent scientific agency.

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Steel Limited

Regd. Office: JSW Centre
Bandra Kurla Complex,
Bandra (East), Mumbai – 400 051
CIN : L27102MH1994PLC152925
Phone : +91 22 4286 1000
Fax : +91 22 4286 3000
Website : www.jsw.in

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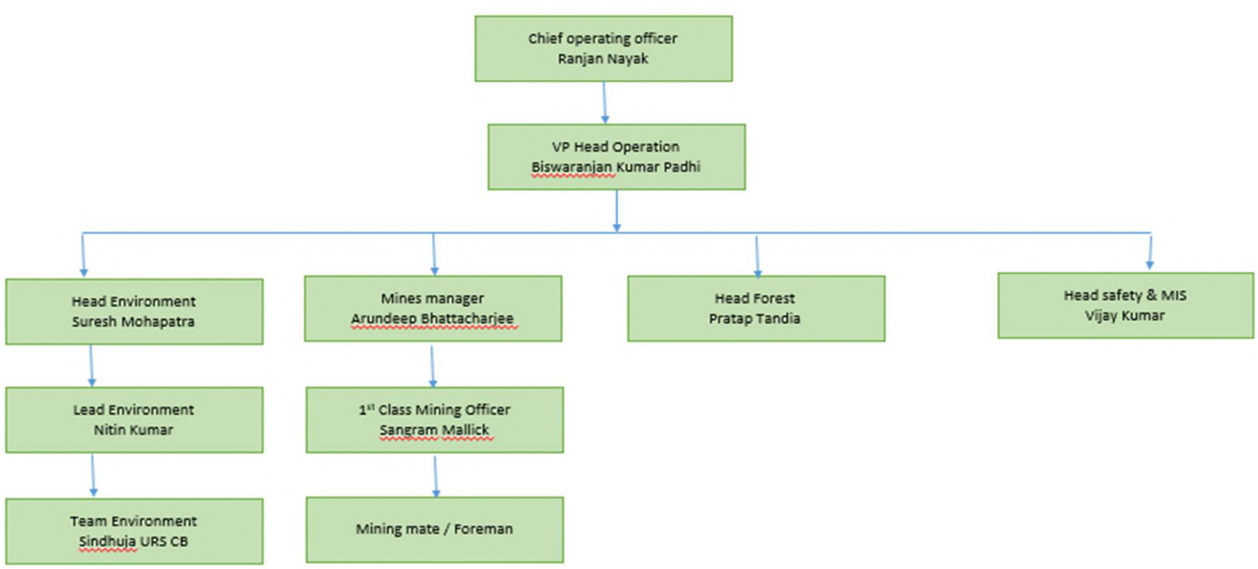
NUAGAON IRON ORE MINES

Environment Management Cell

Environment management cell (EMC) working for the management of Environmental monitoring of the mines and to act upon mitigation measures on the impacts of the production of mine with its surrounding environment so that pollution load, water and air quality can be maintained. Key functioning of EMC would be for compliance monitoring and to adhere with Environmental aspects and issues of the project during operation phase. EMC created with an objective of organizational framework for operating Environment Management System (EMS) and other functions of responsibilities for environmental betterment; and formulating Environmental Action Plans (EAPs) which specify mitigation, periodic and annual monitoring activities during project implementation and operation phase of mining.

The potential activities structured for the control mechanism by EMC, such activities are: Air pollution due to the emission of particulate matter, Gaseous pollutants and fugitive emissions; Noise pollution due to various noise generating equipment and mining activities; Wastewater generation from domestic activities; and Solid waste disposal. In order to minimize these impacts and to ensure that the environment in and around the project site as well as the neighboring population is well protected; an effective environment management plan to be developed and maintained by Environment management cell.

Organogram



Ranjan Nayak
Chief Operating Officer