

# Extraction of Sand from Waste dumps of Mining: A New Approach to Address the Environmental Issue of Goa

Ayapilla Narasimha Murthy

Lecturer, Civil Engineering Department, SRM University, Andhra Pradesh, India

E-mail: narasimhamurthy.a@srmmap.edu.in

**Abstract** - Goa is India's smallest state by area (3700 sq.km) but rich of mineral deposits such as -iron ore, manganese ore, bauxite and many minor minerals like basalt, laterite stones, rubbles, river sand etc., Exploration and exploitation for iron ore has started at the beginning of the 20th century. Iron ore mining in Goa is completely in the private sector. The mining belts extend over a length of 65km from SE to NW of the State covering around 700 sq.km. The iron ore deposits are distributed over the Northern, southern, and central blocks of Goa. It is the only state with large area under mining. Mineral production in Goa started in the late 1940s. Initially with Manganese ore but later shifted to iron ore with phenomenal growth in production. Every year around 60million tonnes of iron ore was being handled till 2015. Subsequently capping has been imposed by Hon'ble Supreme Court to mine 20 million tonnes from 100 mines by open cast method to control the pollution levels. The mining is carried out by mechanized methods and generated large number of employments, around 5 lakh people by both direct and indirect means. The state is having 400 million tonnes of iron ore resources. The highest production of iron ore from Goa was 40 million tonnes per annum in the past, but for extraction of everyone tonne of ore approximately 4 tonnes of waste rock has to be removed as the mining has gone deep and extent of each lease area is small. The waste rock comprises manganiferous and phyletic clays which are soft and easily erodible. Further, Goa witnesses heavy rainfall up to 3500mm during SW monsoon every year, thus the surface waters are getting polluted. As said above the lease areas are being small and the generation of waste rock is high. So, the disposal of waste rock and its prevention poses a problem. The analysis of waste rock indicates the waste rock is rich of sand grains which can be extractable by simple crushing and screening method. So, a detailed conceptual plan is necessary to sustain the mining and to tackle the environmental issues which are suggested in this paper.

**Keywords:** Clays, Environment, Goa, Iron Ore, Mining, Sand, Sustainability

## I. INTRODUCTION

The iron ore deposits of Goa were formed during pre-Cambrian period (around 1800 million years ago) either by a process of leaching or by replacement from a metamorphic rock called Banded Haematite Quartzite. The iron ore deposits are occurring in the form of stratified formations over a length of 700 km long from sirigao village in NW to Barazan in SE direction. The iron ore formations occur as broadly and intensely folded bands whereas manganese ore occur as isolated pockets. The entire mining belt of Goa state is under an ecologically fragile zone. The production of iron ore by open cast

method has gone upto 40 million tonnes during 2007-2010. Subsequently it was reduced due to environmental issues.

## II. ENVIRONMENTAL ISSUES

### A. Legislation

The Acts which have been enacted for prevention and control of pollution of air, water and forests in the country are

The water (prevention & Control of Pollution) Act, 1974 and Rules made there under to 1975. The Air (prevention & Control of Pollution) Act, 1981. The Forest (Conservation) Act, 1980 and Rules made there under in 1981. To cover the air, water, noise pollution and all other constituents of environment an umbrella Act was enacted by way of Environmental (Protection) Act, 1986 and Rules framed under it in 1987. As per these acts every mining company/miner has to prepare an EMP (Environment Management Plan) which will cover the mitigation measures of the damaged environment due to their mining activity. It should be implemented or followed strictly. The main spirit in the implementation of these control measures is to achieve not much time lag between commencement of damage to environment and the commencement of repairs to the various environmental parameters that are being affected. For this it is essential to generate a base line data on which the impact assessment as well as the protection and control measures can be arrived at.

The main features incorporated are surface geology of the area, surface drainage pattern, hydrology, climatic data, air quality, water quality, noise quality, ground vibration study, soil quality and socio-economic status. Normally the base map preparation is in two parts. One specific to the work/core zone and the other buffer zone covering up to 5 or 10km radius.

### B. Problem

The problem with the exploitation of iron and Manganese ore deposits is the removal and storage of waste rock outside the lease area. Since, the ore to waste ratio has gone up to as high as 1:4 (i.e. for extraction of every one tonne of ore approximately 4 tonnes of waste rock is to be removed and stored). Now, mining has become difficult,

because of waste handling, as the waste rock is soft and clayey material thus, deep mining poses a problem.

### III. RESULTS AND DISCUSSION

The waste rock comprises 20% siliceous white waste, 25% black manganese clays, 23% pink phyllite clays and the rest are friable altered intrusive rocks and lateritic waste. The ore body is continuing deep, but of narrow lease area and high rainfall the wall rocks are not stable. So, open cast mining has become difficult adhering the environmental laws. As per the amended MMDR Act, 2015 the quantity of generated waste rock should not be disposed as it attracts illegal mining. So, it should be disposed with due prevention measures for which suggestions are proposed in this paper.

The concentration of many trace elements tends to increase from rock to soil and water. The increase and decrease of concentrations depends on the nature and the geochemical behavior of the trace elements.

For eg. Selenium approximately ten folds increase from the original weathering of igneous rocks to the formation of sedimentary counter parts and water.

The element Iron is enriched into the river waters. It's concentration is more than 2mg/l and is harmful. It may cause skin and stomach diseases. During the process of mining and beneficiation the element Fe is released and in contact with surface waters it goes into solution. The phosphorous content is high where the waters are in contact with the igneous intrusions.

The high phosphorous content causes hypertension and pulmonary diseases. The manganese content exceeds it affects kidneys, brain etc. the arsenic content goes beyond permissible it will damage liver, lungs. Free silica is responsible for the disease known as silicosis. The smaller/micro size particles of manganese dust affect the nervous and respiratory systems. Also, causes mental imbalance, insomnia, and manganese poison.

TABLE I CHEMICAL ANALYSIS OF WASTE ROCK

Sl. No.	Waste rock	Fe%	Al <sub>2</sub> O <sub>3</sub> %	SiO <sub>2</sub> %	P <sub>2</sub> O <sub>5</sub> %	Mo in ppm
1	Laterite	38.11	18.79	27.55	-	15
2	Manganiferous clays	39.10	6.53	1.59	0.19	12
3	Phyllitic clays	27.84	11.23	38.68	0.21	14
4	Altered igneous intrusives	24.06	23.24	28.32	0.76	13
5	Beneficiation plant slimes	51.39	7.65	28.84	0.28	16

The different waste rocks were crushed and dry screening was adopted and recovered more than 25% sand from all the above types of waste rocks except Manganiferous clays. The produced sand may be used in construction industry. Since, large quantity of surface and pit water is available the sand could be washed and marketed. By which about 25% space and waste rock management can be done. The water analysis indicated that the heavy metals like Pb, Cu, Zn, Cd

contents are high. Also, chloride is high. Molybdenum when it exceeds it causes 'molybdenosis' which interferes the growth, nutrition and reproduction. The laterites are rich of trace elements of B, Ga, Ge. If Boron content is high it leads to cancer. Mining is the back bone of the Goa states economy after Tourism, so it has to continue. About 5 lakh people are employed both direct and indirect means. Thus, mining has to continue keeping the Environmental laws.



Fig. 1 A Panoramic view of a Mine in Goa

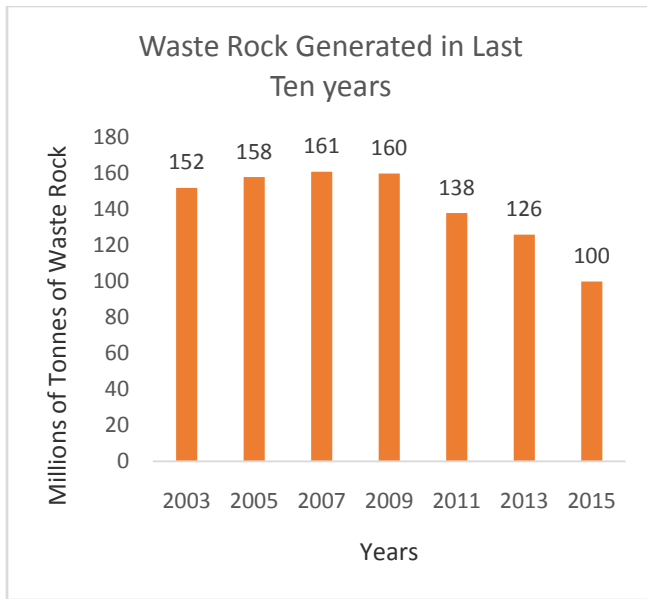


Fig. 2 Graph depicting the quantity of waste rock

The flow chart is as follows

Waste rock-----> Crushing (dry) -----> Screening--> 2mm size -----> Washing with water jet ---> finished product.

The recovery percentage is upto 80%. The cost per tonne will be very low. The lab scale tests are encouraging. As the ore has to be transported by road to the ports for export purpose along distance air pollution has increased. This has caused concern among the residents over a period of 20 years. So, there are many PIL (Public Interest Litigation) cases have been filed in different courts. Recently, the Hon'ble Supreme court has ordered to restrict/cap the mining to 20 million tonnes only keeping carrying capacity of the roads. So, the miners are in great stress, and a challenge is ahead that an economical extraction of ore is one hand and protection of environment is on the other. The Mine closure planning is relatively new concept, so excavation from a new pit should begin only after an existing pit has been exhausted. This would ensure that the overburden and inter burden generated is used for backfilling the exhausted pit, instead of being dumped elsewhere. Till a pit is exhausted, the overburden should be

properly compacted and stacked in specified locations in low-lying non-mineralized zones within the lease area. The height and slope of the overburden dumps should be maintained to prevent accidents. Drainage should be considered to handle heavy rainfall. Sedimentation tanks should be constructed to treat run-off waters.

#### IV. CONCLUSION

It is concluded that for sustainable mining, purpose, the miners should extract sand from the waste dumps to reduce the issue of space for dumping. For systematic mining, the extraction of ore should commence from one end of the lease area to the other end. The mined-out area should be backfilled with waste rock, immediately so that more land will be available for use. The miners have to restrict their mining activities within the lease area, to reduce pollution. Alternately, with due permissions, identify some of the deep valleys in the Western Ghats hilly area and fill it with waste rock, so that more area will come under use. Every miner should adopt 'zero mining concepts' by utilizing the waste rock for manufacture of bricks and building materials. The siliceous waste rock can be used for manufacturing of concrete by adding fly ash and other cementitious material. A civil engineering project can be taken up by identifying, wherever high quantity siliceous waste rock is available.

Thus, every mining company should prepare a long range conceptual mining plan adhering to the laws for a period of next 20 years regarding how to extract the ore and how to preserve the waste rock keeping the ecological balance for sustainable mining. Thus mining companies' tandem with zero mining concept in one hand and preserving the environment by adhering to the more stringent environmental laws on the other.

#### REFERENCES

- [1] Priyanka Bhade and Purnananda P. Savoikar, "A case study of Geotechnical investigations for soft laterite soil site in South Goa", published in *Recent Developments in Sustainable Infrastructure*, pp. 69-77, 2020.
- [2] K. Desai, *Geology and Mineral Resources of Goa*, first edition, 2018, New Delhi Publishers, pp. 11-34, 2018.
- [3] Mascarenhas and G. Kalavampara, "Proceedings of Natural Resources of Goa - A Geological perspective", *Geological Society of Goa, Miramar, Goa*, pp. 97-118, 2009.