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Soil Hazards Due to Marble Slurry

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Abstract: ***Marble slurry formed during various steps of marble tile production like crushing, grinding, polishing etc. this slurry when mix with soil results in serious hazards. The amount of calcium and magnesium ions is very high in and these percolate in the ground water as well as in soil and pollute both. Marble slurry also affects pH of soil as it itself is highly alkaline and ultimately makes soil unfertilised.***

Keywords: marble slurry, soil hazards, mining

1. Introduction

India has been eminently endowed with a gift of mineral resources and therefore renowned as the home of exquisite natural stones like granite, marble, slat and sandstone not only for decades, but for centenaries. There are many evaded that exploitation of minerals like coal, Iron-ore, Copper, Load, Zinc, Stone has been going on in the country from time immemorial. However the first recorded history of mining in India dates back to 1774, when an English company was granted permission by the East-India company for mining coal in Raniganj.

Mining is a very large source of natural resources for improvement in human life. The exploitation of these resources caused the degradation of potential ecosystem of the country at an accelerate rate. Ecosystem degradation by mining is the part of industrialisation and civilisation. All natural resources are bestowed for us by nature and are non renewal resource. Mining activities produces dangerous materials and may take place at same site. Environmental issues can includes erosion, formation of sink holes, loss of biodiversity, and contamination of soil, surface water and groundwater by chemicals from mining process. In some cases additional forest logging is done in the vicinity of mines to increase the available room for the storage of the created debris and soil. Besides creating environmental damage, the contamination resulting from linkage of chemical, also affect the health of local population. In the areas of wilderness mining may cause destruction and disturbance of ecosystem and habitats. In the areas of farming it may disturb or destroy productive grazing and crop lands. In the urbanised environment mining may produced noise pollution, dust and visual pollution.

After the mining ends land is generally useless and may continue to cause environmental hazards long after the mine has closed. When the mine is underground and is composed of tunnels, the disturbance is usually localised at the entrance of mine unless there are later cave -ins or some interference with ground water.

Rajasthan is famous for its marble deposits. There are around 4000 marble mines and about 1100 Gang saws (processing unit) in medium sector, spread over the 16 districts of Rajasthan. Marble slurry is generated as a by product during cutting of marble. The waste is approximately in the range of 20% of the total marble handled. The amount of marble slurry generated in Rajasthan every year is very substantial being in the range of 5-6 million tonnes. When this slurry is dries up it cause serious environmental pollution. (Kushwaha, 2014)

While marble block are cut by gang saws, water is used as a coolant. The blade thickness of the saws is about 5 mm and normally the blocks are cut in 20mm thick sheets. Therefore, out of every 25mm thickness of marble block, 5mm are converted into powder while cutting. This powder flows along with the water as marble slurry. Thus, nearly 20% of the total weight of the marble processed results into marble slurry. The marble slurry has nearly 35%-45% water content. The total waste generation from mining to finished product is about 50% of mineral mined.

The major adverse effect of surface mining are disruption of the soil, plant stability circuit. (Harthill and Mckell, 1979), the geology, increased nutrient export from the system {Stark, 1977), depletion of soil organic poll and disequilibrium in the geomorphic system.

Marble mining at Makranaand other areas is a classic example of unscientific mining and improper waste disposal. Marble cutting units are also throwing the marble slurry in open spaces and on the road side. It has caused land degradation, ponding and flooding of water. Visual impact loss of aesthetics, air and water pollution, health and safety hazards. The processing waste going to the riverbeds is threatening the porosity of aquifer zones and contaminating the underground water reserves. The marble slurry imposes serious threats to the ecosystem, physical, chemical and biological components of the environment. Some of the major problems encountered are:

1. When dumped on land, it adversely affects the productivity of land to decreased porosity, water absorption, water percolation, contamination of top fertile soils etc.

2. After drying, the fine particles (with size less than 363 micron) become airborne even with mild breeze and cause severe air pollution. It enters the lungs causing respiratory troubles and other wide - ranging human health problems such as increase in mortality, diminished ventilatory function, sensory irritation, earaches, cardiovascular diseases, etc.

3. Apart from occupational health problem, it also affects machinery and instruments installed in industrial areas. Slurry dumped areas can not support any vegetation and remains degraded.

2. Materials and Methods

Study Area: Makrana (Latitude 27°02'25" EN; Longitude 74°43'44" E)is situated at eastern margin of the Thar desert and has an ancient marble mining history. The Makrana marble has made a perceptible dent in marble industry because of its block ability, whiteness, (high CaO 50-56 %, low MgO 0.90-1.77 %), good polishing character and lustre. It is fine grained and exhibits stable, well distributed colours, pleasing and attractive designs and patterns. The translucent varieties of Makarana marbles are preferred over other marbles for monumental and sculptures work (Natani 2001).

This site was selected as disturbed site. However, disturbance due to marble allied activities in less severe type. The presence of crushing, cutting and polishing units in marble factories area produces a lot of marble slurry {Marble waste material}

The basic raw materials used by these units are silica and water, after use which forms slurry. The slurry is disposed off on the open land such as agriculture field without any treatment. As the slurry is in liquid form with rich in calcium, magnesium contents, these contents therefore percolates in the ground water as industrial discharge. Due to effluent contamination turbidity, total suspended solids pH and concentration of different heavy metals increases with apparent reduction of transparency and decreased level of dissolved Oz. Such changes degrade the water quality and cause water pollution. Danwar, S. (2012)

Chemical - Characteristics

(1) Moisture- Content: Immediately after soil collection, fresh and oven dried weight

{105°C till content weight was attained} were taken and moisture content was calculated by following formula:

$$\text{Moisture Content \%} = \frac{\text{Fresh weight - Dry weight x 100}}{\text{Dry weight}}$$

(2) Soil Reaction (pH): pH was determined in 1: 5 (wt/vol) soil suspension using systronics digital pH meter.

(3) Alkalnity: 100 ml of 1: 5 (wt/vol) soil solution was titrated against 0.1 N hydrochloric acid by using Methyl - orange - indicator. At end point, colourless solution turned into pink {Trivedi et al., 1987).

Alkalinity (mg/100g): = AxNx 1500 / V

Where: A= Volume of 0.1 N Hydrochloric acid used (ml)

N= Normality of hydrochloric acid (0.1 N)
V= Volume of soil solution used (100ml)

(4) Chloride: Chloride content was determined titration of 50 ml of 1.5 soil suspension (wt/vol) against 0.02 N silver nitrate solution using 5% potassiumdichromate as indicator.

Chloride % =AxNx 35.5/Vx2

Where: A= Volume of silver nitrate used (ml)

N= normality of silver nitrate (0.02 N)
V= Volume of soil extract (50 ml)

Preparation of soil leachate for the estimation of total cations:

100 ml ammonium acetate was added to 50g of sieved oven dried soil. The solution was kept overnight and then filtered. The final volume of filtrate was made up of 500ml by adding distilled water.

(1) Calcium: Calcium was determined by EDTA filtration method as described by Trivedi, et al. (1987). 2 ml of 1N sodium hydroxide and approximately 100 mg murexide indicator were added in 50 ml ammonium acetate leachate. This solution was titrated against 0.1 M EDTA solution. At the end point, pink colour turned.

Calcium (%) =Ax 400 .8 x V/Vx 1000
Where, A= Volume of EDTA used (ml)

V = total volume of soil extract prepared (500 ml)
V=Volume of soil extract titrated (50 ml)
S = weight of soil taken (50 g)

(2) Magnesium: Magnesium was determined by EDTA filtration method. 1 ml of buffer solution and approximately 100 mg of Eriochrome Black – T indicator were added in 50 ml ammonium leachate. This solution was titrated against 0.01 M EDTA solution. At the end point, colour of the solution turned to blue.

Magnesium (%) = B xV x 400.8/ v x Sx 1.645 x 1000

Where: B= volume of EDTA used (ml) and
V = total volume of soil extract prepared (500 ml)
S = Weight of soil taken (50 g)

(3) Nitrogen: Total percent nitrogen content was determined by conventional Micro - kjeldhal method 10g of sieved oven dried soil. 25 ml distilled water, 20 g catalytic mixture and 35 ml of concentrate sulphuric acid were taken in a digestion flask. The contents were mixed at low heat and after 5 - 10 minutes heating was increased Digestion was continued till the contents became apple green on completion of digestion the digest was cooled and diluted by adding 100 ml of 40 % NaOH in round bottom Kjeldhal flask. Distillate was collected up to 150 ml in conical flask containing 20 ml boric acid and few drops of mixed indicator. It was titrated against 0.1N hydrochloric acid. Distilled water blank was run using all reagents in similar quantity.

Nitrogen (%) = T-B x 10 x N x 1.4/S

Where: T=Volume of hydrochloric acid used in sample

B = Volume of hydrochloric acid used in distilled water titration (ml)
N=normality of hydrochloric acid
S =weight of soil sample (10 g)

(4) Calcium carbonate: To 5 g of oven dried soil, 100 ml of 1 N HCI was added. The solution was kept for at least 1 hour with well stirred intermittently. Remove of 20 ml of supernatant 6-8 dopes of bromothymol blue indicator were added. This solution was titrated against 1N NaOH. At the end point colour changed to blue.

CaCo3 (%): = (B-T) x 5. Where: B = reading with blank. T= reading with soil.

(5) Phosphorus: Percentage of exchangeable phosphorus was estimated by calorimetric method - using molybdenum blue. 200 ml of 0.002 N sulphuric acid was added in 1g oven dried soil, It was shaken for half an hour and then the suspension was filtered. To 50 ml of filtered suspension, 2 ml of ammonium molybdate and 3-4, drop of stannous chloride were added. A blue colour appeared. Absorbance was recorded after 10 minutes (but not more than 15 minutes) by using systronics. Spectrophotometer model 119 at 690 nm. Percent phosphate was determined with the help of standard curve. A suitable series of potassium hydrogen phosphate concentration was prepared for standard curve.

(6). Carbon: Carbon was determined by chronic acid digestion method {Walkley and Black, 1934). 10 ml of 1 N potassium dichromate flask containing 10 g sieved soil. The content was mixed by gentle swirling. After 30 minutes when reaction was completed the solution was diluted with 200 ml distilled water. 10ml concentrated phosphoric acid and 1 ml diphenylamine indicator was added simultaneously in this diluted solution. The bluish purple coloured solution was titrated with ferrous ammonium sulphate solution until the colour changes to brilliant green. To get sharp and point, a pinch of salt was added before titration. Carbon percentage was calculated by the following formula:

Calculation Carbon %=. V2-V1 x .003. x. 100/W

Where: V1 = Volume of potassium dichromate (ml)

V2 = Volume of ferrous ammonium sulphate used (ml)
W = Weight of soil taken (10g)

3. Observation

Table 1: Chemical analysis of soil surface at Various Sites in Makarana

S.no. Sites	pH	Alkalinity Mg/100g	Chloride	Calcium Cabonate	Ca ions %	Mg ions%	Na ions %	K ions %	Po3 ions %	N %
1	8.32	14.43	1.198	0.34	4.465	0.983	0.098	0.029	0.078	I.08
2	8.15	10.02	0.654	0.65	2.878	1.187	0.089	0.017	0.298	0.46
3	9.26	13.21	0.439	1.03	1.367	0.895	0.145	0.037	0.746	1.12
4	9.01	9.15	1.232	0.66	6.671	1.117	0.102	0.069	0.067	0.03
5	8.12	27.91	0.329	1.69	1.897	1.247	0.079	0.086	0.585	0.28
6	8.21	14.22	0.851	1.22	4.969	0.436	0.029	0.067	1.097	0.09

4. Results and Discussion

The soil moisture of the analysed samples varied from 1.5 to 3.7% in surface soil. Soil moisture at different sites increased with the depth.

Soil pH controls the base status in soil and microbial activities in the soil. So that the study of soil pH is important. The soil pH affects the physical condition of soil. Soil pH effects on plant growth and good guide for predicting that which plant nutrient are likely to be deficient the pH values of all the soils were within the range of 8.12 to 9.26 in surface soil. It shows that the soil by nature is saline. Soluble salts present in the soil. When soluble salts come in soil solution it dissociate into their respective cations and anions. These anions and cations carry impart conductivity and current. The high concentration of ions in the solution more is its electrical conductance. So that the soluble salt concentration can be directly related to the measurement of electrical concentration can be directly related to the measurement of electrical conductance. Although the relationship between salt concentrations and conductivity varies. Somewhat depending on the ionic composition of the solution, the electrical conductivity provides a rapid and reasonable accurate estimate of solute concentration.

Calcium is the important chemical factor of the soil which affects the restriction of various plants species to the respective soil types. Calcium plays an important role in soil among the entire chemical element. The percentage of calcium carbonate, phosphate, potassium is high. In affected soil which can be correlated to the dust fail in the area. The calcium values of the sample varied from 1.367 to 6.671in surface soil.

One of the most widely used rapid soil test for the measurement of available nitrogen is based upon the estimation organic carbon, which roughly represents 58% of the soil organic matter, the seat of nitrogen in soil. This technique has been found to work fairly well unless the bulk of the organic matter is non-humid in nature and the organic carbon values are on the very higher side. Soils have been classified as low, medium and high organic carbon content. According to the above classification soil of Makranaarea comes under the class of medium carbon content. So that the soil of Makranaarea would partially restrict the agricultural productivity. The major part of soil nitrogen exists as complex combination of soil nitrogen break down to simple forms followed by mineralization. Then it becomes available to crops. Hence easily oxidisable organic carbon and mineralisable nitrogen to be quite satisfactory as increase of nitrogen availability of soils (Kabata-Pendias, A. 2010). In soil nitrogen generally occurs in the form of organic compound nitrate and ammonium. The deficiency of nitrogen limits the production of protein and other essential materials for the production of new cell all parts of the plant are affected including the shoots as well as roots. The analysed samples for nitrogen varied from .03 to 1.12% in surface soil.

Plant usually contain large amount of chlorine so the small amount of chlorine will be sufficient to must the need of plants. Plant use chlorine in the chloride form the chloride plays an important role for plants. The functions of chloride ions suggested by Goos (1987b).

Chloride ions control the stomatal opening with K ions chloride activates the certain enzymes such as alpha amylase chloride also plays an unique rule in oxygen evolution part of photosyntheses. Adequate resistance to many plant diseases the chloride content of soil samples was found to be high in the range of 0.329 to 1.232% in surface soil. Hence the underlying soil is not suitable for the growth of crop.

Phosphorus in soil ranges from 0.01 to 0.3% and occurs in several form and combinations. About 95% or more of the soil phosphorus is the original source of the apatite group of primary minerals the different phosphate compounds in soils can be generally classified as fluro-carbonate and hydroxy phosphates of Fe, Al, Mn, Ca, Ti and Mg of which the Fe, Al, And Ca phosphate are the most important ones Quantitatively. The total amount of phosphorus. So that the deficiency of phosphorus causes stunting delayed maturity and shrivelled seed the concentration of phosphorus varied dorm .067 to 1.097% in surface soil. The levels of phosphorus and nitrogen in the soil investigated are low. Very little information is available regarding differential Response to these nutrients by natural population of wild species. So that the agricultural productivity is low in the soil of Makarana area.

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