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# Geological Investigation of Coal Mine Refuse For Backfilling in Mines

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**Abstract** - *Coal is an important source of energy and also used for power generation. The coal is extracted from the coal mines and then used for the power generation. Basically coal is the primary source used for cement production, carbon fibers and foams, medicines, tars, synthetic petroleum based fuels, and home and commercial heating. The mining industry operates through a sequence of stages: exploration, discovery, development, production and reclamation. After the excavation of coal the excavated soil remains unused and heaps and heaps of soil is just piled up on site. After the full service of coal mine at the time of mine closing this soil can be used for backfilling. But the service period of coal mines can range between 5 – 70 years. So the piled excavated soil either can be used for backfilling or can be used in construction. So proper tests are carried out on the coal soil which determine whether the soil can be used for backfilling or is good to be used in construction. The reuse of this coal soil is a great step towards saving soil and environment.*

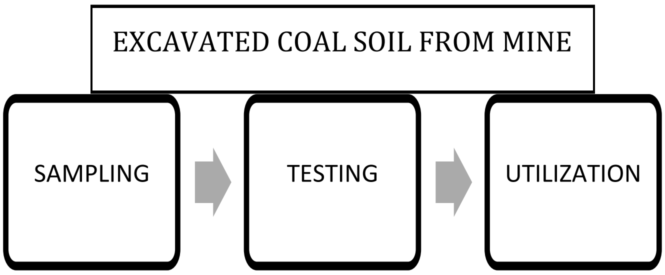
***Key Words***: Geological investigation, Coal mines, Backfilling.

## 1. INTRODUCTION

At present, the power sector in India is dominated by coal. Coal currently accounts for more than 50% of total primary commercial energy supply in the country and for about 70% of total electricity generation. Coal is likely to remain a key energy source for India, for at least the next few decades, as India has significant domestic coal resources (relative to other fossil fuels) and a large set of existing installed base of coal-based electricity capacity, although recent experiences have thrown into sharp relief the uncertainties and concerns regarding the adequacy of coal supplies to satisfy the growing hunger for power.

The coal-based power, local environmental and social challenges relating to coal mining, processing, and use are becoming more pressing. In India also problems of mining waste are there and hundreds of hectares of area around the mine are used for dumping of overburden and low grade ore. The top soil which is very important for agricultural purpose is lost in huge quantity. As per Indian rule the height of the dumped overburden cannot be more than 60m, so, large areas are acquired for dumping of these overburden and low grade ores.

## 2. METHODOLOGY




After discussing with our helpful and supportive guide Prof. Rakesh Kumar and taking permission letter of site visit from college we decided to take a site visit to the MAKARDHODKA COAL MINE situated in the Nagpur district, Bopeshwar, Maharashtra-441203. This is the highest coal making company in Maharashtra. This coal mine is runned by the WESTERN COAL LTD. NAGPUR. We booked the tickets for the train and began our journey this was a very interesting speed paced journey. We got a lot of information regarding the coal mines and backfilling in coal mines which was the main purpose of our project. This visit was arranged by resp. Sudhir Giradhar sir (Coal mine supervisor) they were very helpful to us and were supportive within the coal mines rules and regulations.

We were provided with one guide named Mr. Sandeep Gupta (sector 1 mine incharge). He answered some of our questions and some of our question were solved by Google. The coal production from the mines is around 2.73 million metric tons per year and our state Maharashtra is top 10 from the list producing 12.963 billion metric tons. Except coal mines also have minerals like sulfur, salts, limestone, clays, barite, and industrial diamonds. COAL, COPPER, GOLD, GRAVEL AND IRON ORE are mined from the mines creating reserves for the country. The mines excavated waste is used for underground filling, backfilling and closing of coal mines and also used for construction purposes and layered around the uneven surface.

This project is intended to perform various laboratory tests to help to evaluate the suitability of coal refuse as a backfilling/stowing material. These include the following tests:

Plasticity: - Since plasticity affects the strength and permeability characteristics of a sample, its assessment are necessary.

Compaction Test: - Compaction can considerably increase sample densities in comparison with the densities of the loose samples.

Permeability Test: - The ability of the in situ fill to dissipate pore pressure is affected by its permeability characteristics which in turn are affected by the percentage of fine particles in the fill.

Particle Size Analysis: - To illustrate the concept of particle size distribution (PSD) the details about the experimental setups and procedures have been presented here.

## 2.1 LIQUID LIMIT PLASTIC LIMIT

Fig1. Liquid limit apparatus

Fig2. Performing the test

| S. No. | Empty weight of the pan (in gram) | Weight of soil + pan (before heating) (in gram) | Weight of soil + pan (after heating) (in gram) | No. of blows | Moisture percentage | Average moisture percentage |
|---|---|---|---|---|---|---|
| Mine 1 | | | | | | |
| 1. | 5.61 | 22.80 | 17.73 | 35 | 29.65 | |
| 2. | 5.93 | 23.33 | 18.06 | 28 | 30.40 | 30.35 |
| 3. | 5.45 | 22.12 | 17.01 | 25 | 30.53 | |

Table1. Results of liquid limit of coal soil

| S. No. | Empty weight of the pan (in gm) | Weight of soil + pan (before heating) (in gm) | Weight of soil + pan (after heating) (in gm) | Moisture percentage | Average Moisture percentage |
|---|---|---|---|---|---|
| Mine 1 | | | | | |
| 1. | 5.19 | 11.11 | 10.24 | 15.25 | |
| 2. | 5.61 | 11.32 | 10.41 | 15.79 | 15.42 |
| 3. | 5.40 | 10.01 | 9.31 | 15.22 | |

Table2. Results of plastic limit of coal soil

## 2.2 PERMEABILITY TEST

Fig2. Permeability test apparatus

| S. No. | Head h (cm) | Quantity of water Q (cc) | Time t (sec) | Permeability k ($x 10^{-5}$ cm/sec) | Average Permeability k ($x 10^{-5}$ cm/sec) |
|---|---|---|---|---|---|
| Mine 1 | | | | | |
| 1 | 235.8 | 245 | 900 | 18.824 | |
| 2 | 235.8 | 502 | 1800 | 19.285 | 19.072 |
| 3 | 235.8 | 746 | 2700 | 19.106 | |

Table3. Results of permeability test of coal soil

### 2.3 COMPACTION TEST

Fig3. Proctor Compaction apparatus

| $W_1$ | $W_2$ | $W_2 - W_1$ | $W_3$ | $W_4$ | $W_5$ | M | Y | $Y_d$ |
|---|---|---|---|---|---|---|---|---|
| Mine 1 | | | | | | | | |
| 2.196 | 4.198 | 2.002 | 13.32 | 45.08 | 42.40 | 8.44 | 2.040 | 1.881 |
| 2.196 | 4.307 | 2.111 | 12.61 | 51.02 | 47.35 | 9.55 | 2.151 | 1.964 |
| 2.196 | 4.399 | 2.203 | 12.19 | 55.28 | 50.73 | 10.56 | 2.245 | 2.031 |
| 2.196 | 4.352 | 2.156 | 12.57 | 51.95 | 47.50 | 11.30 | 2.197 | 1.974 |

Table4. Results of compaction test

### 2.4 PARTICLE SIEVE ANALYSIS

Fig4. Particle Sieve shaker with sieves

| Sample No. | $C_u$ | $C_c$ |
|---|---|---|
| Mine 1 | 60.00 | 0.0667 |

Table5. Coefficient of Curvature and Coefficient of Uniformity of samples

### 2.5 SITE VISIT TO MAKARDHOKA COAL MINE

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Fig5. Makardhodka coal mine

Fig6. Levelling of uneven land using coal soil

Fig7. Working at coal mine sector 1

**MAKARDHODKA COAL MINE DETAILS**

Sponsor: Western Coalfields Limited

Parent company: Coal India Limited

Location: Bopeshwar, near Umrer in Nagpur District,

Maharashtra, India

GPS coordinates: 20.865366, 79.285604 (exact)

Status: Ongoing

Capacity: 2.0 million tonnes per annum

Production: 2 million tonnes (2020)

Total Resource: Ongoing

Mineable Reserves: 52.863 (Proven, 2019)

Coal Type: Mineral and resource

Mine Size: 660.70 ha

Mine Type: Surface

## 3. DISCUSSIONS

1. The coal refuse may experience wetting and drying cycles during and following placement which can degrade the particles and subsequently alter the fill's mechanical properties. Slake durability testing qualitatively assesses the resistance offered by weak rocks such as shales, mud stones, silt stones and other clay bearing rocks to weakening and disintegration when subjected to two standard cycles of wetting and drying.

2. Resistance to slaking is significant since it can be expected that degradation of the refuse will reduce its strength and permeability.

3. Therefore, it is felt that it would be desirable for coal refuse to be used as stowing material to have at least medium durability

## 4. RESULTS

**(LIQUID LIMIT PLASTIC LIMIT) -** The experimental results show that the liquid limit for the sample of mine 1 lies in low compressible zone, These samples are very low and medium compressible and could be termed very slightly plastic.

**(COMPACTION TESTING) -** It could be observed from the test results that the maximum dry density varies from 1.901 Mg/m3 to 2.207 Mg/m3. When compared with the compacted densities of sand (which varies between 1.7Mg/m3 and 2.2 Mg/m3) which has been successfully used as hydraulic stowing material in India, it could be seen that the refuse from the mine 1 can be suitably used as a backfilling material.

**(PERMEABILITY TEST) -** From the experimental results it may be observed that the samples for mine 1 has the required permeability and is suitable for backfilling.

**(SIEVE ANALYSIS) -** From the experimental results it may be observed that the samples for mine 1 has residual angle of friction less than 300and so they are not preferred for filling purposes.

## 5. CONCLUSIONS

1. Geotechnical tests were performed for the coal mine refuse samples of MAKARDHODKA COAL MINE to evaluate the suitability as filling material. Standard Proctor Compaction test, Permeability test and Liquid and Plastic limit and sieve analysis were conducted on the sample collected from visited coal mine.

2. Geotechnical investigation and analysis is an important study in assessing the suitability of coal mine refuse for backfilling.

3. The results of the performed test will help in determining the adverse environmental effects.

4. The excavated coal soil can be used for backfilling, laying on uneven grounds, construction purposes, idol making, agricultural purposes, etc.

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