Visakhapatnam Chapter

*Proceedings of Indian Geotechnical Conference 2020*
*December 17-19, 2020, Andhra University, Visakhapatnam*

# Study on the Characteristics of Overburden Dump of the Coal Mines

Atul D. Gautam[1] and L. K. Yadu[2]

[1] Research Scholar, Department of Civil Engineering, NIT Raipur, Raipur, CG, India- 492010
[2] Associate Professor, Department of Civil Engineering, NIT Raipur, Raipur CG, India- 492010
atuldevendragautam@gmail.com

**Abstract.** The overburden dump upon excavation from an open cast mines will lead to the problem of loss of fertility of the fertile land, slope failure through the weak plane of the mining area, etc. Hence, the study is done on this aspect at the Singori mines, Near Khaparkheda under the administrative control of Western Coalfields Ltd. The presence of dump has led to a situation where useful land is wasted and the properties of the dump are also not fruitfully invested. This has led to huge waste in the captive area. For any implementation of material in the construction or otherwise, the characteristic determination is inevitable and thus this study delves into the realm of physical and chemical analysis of the overburden dump of the coal mines. After the overall investigation, it has been found that, this material can be utilized as a construction material. This study investigates the critical parameters that the dump posses in order to be meaningfully used in construction technology.

**Keywords:** Overburden Dump, Chemical and physical parameters, captive land.

## 1 Introduction

"The real conflict is not between environment and development, but between environment and reckless exploitation of man and earth in the name of efficiency'-Mrs. Indira Gandhi". Most of the Geo-environmental issues can be avoided or at least reduced to acceptable levels, if good planning and operations are used. It has to be recognized however that the Geo-environmental issues are still evolving in response to new scientific knowledge and an increased priority on social issues. Land is not only a basic resource but also an esteemed asset. It has to be utilized in accordance with its suitability and environmental capabilities, which depends on various factors. However, if unbearable pressure such as of an explosively growing population is brought to bear on the land and to overuse it and over exploit its limited resources, the ecological balance is upset. While the major environmental impacts are well known by most minerals, less attention is focused on geotechnical issues whose impact is less immediate, or less visible. Any project that deals with the interrelationship among envi-

ronment, ground surface and subsurface (soil, rock and groundwater) falls under the purview of Geo-environmental engineering.

**Geo-environmental Issues-** Some geo-environmental issues that are to be kept in mind so as to not harm or destroy the surroundings must be given prior attention. Many times the Land erosion and runoff are the consequences. Remedying the Sites , especially for old abandoned sites is an important task. Transport of the remaining mine wastes and recycling of hazardous mine waste are also the points to be bothered about. For instance, waste from ancillary operations and from power generation.

**Geo-environmental Impact-**The impacts of the overburden dump are such that the river regime gets variations in the discharge , also the ecology affects due to siltation and modified flow. Another impact is thus the alteration in water tables and Change in landform leading to land instability.

Now a day's open cast mining is done dominantly all over the world. During these mining operations huge amount of overburden is generated. This overburden dump management is one of the major issues in mining industry.

Effective management of mine stone is the challenging issue with respect to safety, economy and environmental protection [14]. The improper management of the overburden (OB) dump material leads to many issues. During the mining operation, by utilizing well established methods, it has been found that residual friction angle of the material is one of the important aspects in OB[15]. Based on the properties of this OB material this can be utilized for backfilling in the underground mine voids generated during mining operations [1]. In India a huge amount of waste is generated from various industries, this waste should be utilized in construction or manufacturing construction materials [2]. Various industrial wastes are utilized in construction activities as a supplementary or stabilization material after proper trial and analysis [3].

Utilization of huge amount of the wastes generated in the specified mines is the main aspect of this study. This aspect will help in reducing various geo environmental issues generated in nearby areas due to this mining operation. This paper deals with the specific use of identified coal mine overburden material for the construction activities in the nearby region. This OB material can be utilized in many construction projects after detailed trial and analysis of this material in combination with locally available industrial by-products Suitability of huge amount of OB dump material is identified as a construction material. We will also look forward to substitute various construction materials like sand, pond ash by overburden material.

## 2 Site Details

### 2.1 Location

Singori mines located approximately 30 km away from Nagpur is chosen for the study. It lies in Parseoni district. The commencement date of mine is 17$^{th}$ June 2017. The coal obtained from this mine is used in Khaparkheda power plant and other

nearby small scale industries.Fig:01 shows the sample location of Singori mines that lies in between Silewara and Bina blocks.


**Fig.1.** Sample Location (Singhori Mines)

### 2.2 Establishment of stations in study area

Four stations (S1, S2, S3, and S4) were identified for collection of the samples. Teams of 3 members along with mines representatives have collected the samples. All safety parameters of the mining area were followed by the sample collection team during the field investigation. This zone comes under the topo sheet No. 550/3 of survey of India.

### 2.3 Geology of the area

At this location, loose earth is perceived in the upper layer up to 9.00 meter depth, which is followed by 25.70 meter thick layer of sand stone and clay. Below this, the first layer of coal is encountered and under the first layer, occurrence of coal is observed at various intervals up to a large depth.

### 2.4 Description of material

The sample collected from this location for research work is cohesion-less in nature. This material is formed by the disintegration of coarse grained sandstone during mining operations. This formation is highly weathering in nature .Hence, during mining activities this type of disintegration takes place in a short period of time and can be observed in huge amounts in the block. Such block were explored in about 3.8 sq. km. of area in June 1998 by Central Mines Planning and Design Institute.

### 2.5 Details of OB Material

During field observation, it has been observed that this OB material can be utilized in construction activities after proper analysis. Hence samples were collected as per

standard procedure and the same is transported to the laboratory. Figure No 02 represents the OB material which was tested for various parameters.

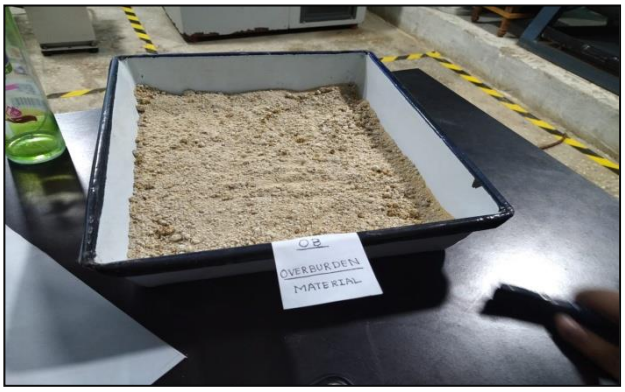


**Fig.2.** OB sample

### 3.1 Testing on OB Sample

This OB material is tested in laboratory for various parameters as per relevant IS codes. Following is the detail for sample testing:-

**Sieve analysis**

Grain size analysis of the collected OB sample has been performed as per IS2720 part 4 1985 [7]. The graphical representation (Graph 01) shows the test results that the silt and clay percentage is very low in the collected sample.

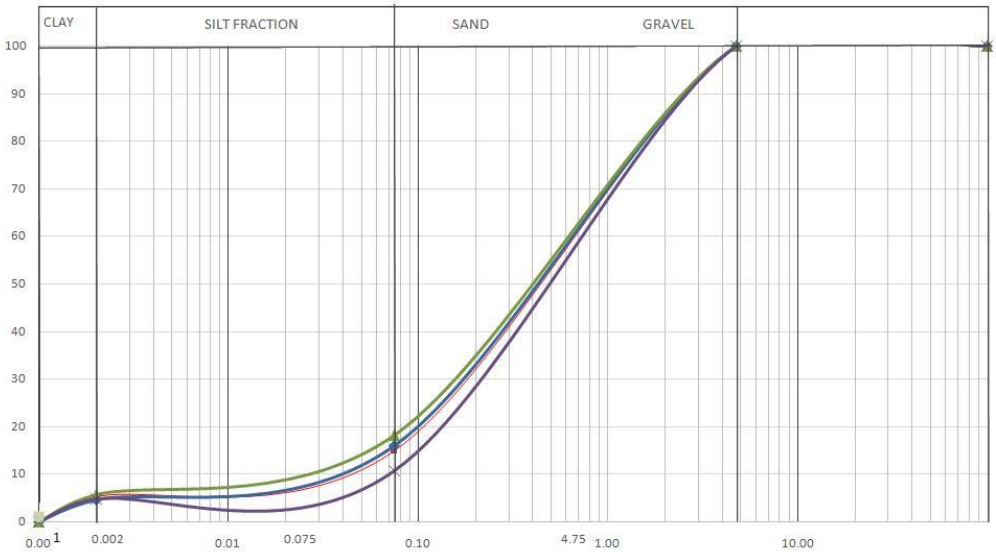


**Fig.2.** Particle size distribution

**Specific Gravity**

Specific gravity test is carried out as per IS 2720 part 3, 1980 [6]. In present case the average specific gravity of the OB material is obtained as 2.524. The value of specific gravity is high as compared to the generalized value of specific gravity of pond ash.

**Atterberg's limit**

This test has been performed as per the IS 2720 part 5, 1985 [5, 8]. The test result indicates that the liquid limit of the OB material is very low and doesn't possess plasticity properties. Pond ash material is also non-plastic in nature.

**Proctor test**

Proctor test is carried out as per the IS 2720 part 8, 1983 [9]. The proctor test results indicate that the OB materials density is comparatively high to that of pond ash.

**Permeability test**

Permeability test has been performed on the OB material as per IS 2720 part 17, 1986 [12]. This test result indicates that the value of permeability of the OB material is in the range to that of pond ash.

**Direct shear test**

Direct shear test has been done on the collected sample as per IS 2720 part 13 1986 [10]. The test results indicate that the OB material is cohesion less in nature with considerable value of angle of internal friction. The value of angle of internal friction is in the same range of the locally available pond ash.

**Consolidation test**

Consolidation test has been performed on the collected OB sample as per IS 2720 part 15, 1986 [11]. The test result indicates that the OB material may be a good alternative of pond ash whenever used as a replacement in construction industry.

**Free swell Index**

This test has been performed on the collected OB sample as per IS 2720 Part XL, 1997 [13]. Test results indicates that the sample is non expansive in nature and within the permissible limit if utilized as a replacement of the pond ash. Table 01 indicates properties of the OB material as per the tests conducted in the laboratory and Table 02 indicates properties of the pond ash collected from NTPC , Mouda.

**Table. 1**. Properties of the OB material

| Parameter | Test Method | S1 | S2 | S3 | S4 |
|---|---|---|---|---|---|
| OMC ( Optimum Moisture Content) | IS 2720 (Part-8) | 11.2 % | 10.5 % | 9.6 % | 12.5 % |
| MDD ( Maximum Dry Density ) | IS 2720 (Part-8) | 14.95 $kN/m^3$ | 14.97 $kN/m^3$ | 14.98 $kN/m^3$ | 14.77 $kN/m^3$ |
| Cohesion | IS 2720 (Part-13) | 0 $kN/m^2$ | 0 $kN/m^2$ | 0 $kN/m^2$ | 0 $kN/m^2$ |
| Angle Of Internal Friction | IS 2720 (Part-13) | $31^0$ | $30^0$ | $29^0$ | $32^0$ |
| Consolidation | IS 2720 (Part-15) | | | | |
| 1) Compression Index Cc | IS 2720 (Part-15) | 0.15 | 0.14 | 0.13 | 0.12 |
| 2)Coefficient Of Consolidation Cv | IS 2720 (Part-15) | 1.81 $x10^{-8}$ $m^2/sec$ | 1.75x $10^{-8}$ $m^2/sec$ | 1.87x$10^{-8}$ $m^2/sec$ | 1.91x $10^{-8}$ $m^2/sec$ |
| Grain Size Analysis | 2720(Part-4) | | | | |
| Gravel | | NIL | NIL | NIL | NIL |
| Sand | | 85.05 % | 84.1 % | 81.8 % | 89.4 % |
| Silt & Clay | | 14.95 % | 15.9 % | 18.2 % | 10.6 % |
| Specific Gravity | 2720(P-3) | 2.515 | 2.520 | 2.530 | 2.530 |
| Free Swelling Index (Fsi) | IS 2720 (Part-XL) | 6.25 % | 7.2 % | 6.72 % | 6.37 % |
| Liquid Limit | 2720(P-5) | 12.35 % | 13.23 % | 12.65 % | 13.74 % |
| Plastic Limit | | NP | NP | NP | NP |
| Plasticity Index | | NP | NP | NP | NP |
| Permeability | 2720 (P-17) | 7.6 X $10^{-7}$ m/Sec | 8.2X $10^{-7}$ m/Sec | 7.9 X $10^{-7}$ m/Sec | 8.1 X $10^{-7}$ m/Sec |
| Sulphate Content | IS: 2720 (Part-27) | 0.00028 % | 0.00018 % | 0.00025 % | 0.00017 % |

| | | | | | |
|---|---|---|---|---|---|
| Chloride Content | BS 1377 Clause-7.3 | 0.00071 % | 0.00074 % | 0.00064 % | 0.00068 % |
| pH | IS: 2720 (Part-26) | 8.97 | 7.8 | 8.2 | 8.4 |
| Organic Impurities | IS: 2720 (Part-22) | ABSENT | ABSENT | ABSENT | ABSENT |

**Table 2**.Properties of the pond ash collected from NTPC , Mouda

| Parameters | Meth-od | Result |
|---|---|---|
| Specific Gravity | 2720(P-3) | 2.16 |
| Liquid Limit | 2720(P-5) | 11.1 % |
| Plastic Limit | | NP |
| Plasticity Index | | - |
| Maximum Dry Density | IS 2720 (Part-8) | 12.85 kN/m$^3$ |
| Optimum Moisture Content | | 24.04 % |
| Cohesion | IS 2720 (Part-13) | 0 kN/m$^2$ |
| Angle Of Internal Friction (ø) | | 32$^o$ |
| Particle Size Distribution | | |
| a) Gravel | 2720(Part-4) | Nil |
| b) Sand | | 32.4 % |
| c) Silt | | 64.2 % |
| d) Clay | | 3.4 % |

## 4 Results and Discussion

Based on the material characteristics of samples collected from mines, it has been observed that OB material satisfies the requirements of pond ash as per the requirements of IRC 58-2001 table 01 for the typical geotechnical properties of fly ash [4]. Hence, it is recommended that this OB material, whose management is a big challenge for the mining industries, can be efficiently utilized in the construction projects to make the best out of waste generated in order to promote sustainable development.

## 5 Conclusions

Following conclusions can be drawn, from the test results:

1. After proper trial and analysis, this overburden material can be used in combination with locally available marginal material like fly ash and industrial waste in different percentage in various construction activities i.e. Highway Construction, Embankments etc.

2. The OB material can be utilized as a soil stabilizer or filling material etc. Other environmental problems and their possible mitigations can be proposed to the mining authorities during further research work of overburden dump.

## References

1. Anup Kumar Gupta and Biswajit Paul, "A review on utilization of coal mine overburden dump waste as underground mine filling material: a sustainable approach of mining , *I*nt. J. Mining and Mineral Engineering, Vol. 6, No. 2 (2015)
2. Asokan pappu , Solid Waste generation in India and their recycling potential in building Materials , 19 April 2006 , Building and Environment. (2006)
3. Bharathi Ganesh et al. "Effective utilization of pond ash for sustainable construction" october 2011 , International Journoul of earth sciences and Engineering (2011)
4. IRC SP 58 : Guidelines For use Of fly ash In road embankments, Indian Road Congress New Delhi. (2001)
5. IS: 2720 –(Part – 2) Method of test for soils : Determination of water content (Second Revision). Bureau of Indian Standards, New Delhi. (1980)
6. IS: 2720 (Part – 3) (Section – 1) Method of test for soils: Determination of Specific Gravity : Fine Grained Soils. Bureau of Indian Standards, New Delhi.(1980)
7. IS: 2720 (Part – 4) Method of test for soils: Grain Size Analysis. Bureau of Indian Standards, New Delhi.(1985)
8. IS : 2720 (Part – 5) Method of test for soils : Determination of liquid & plastic limit (Second Revision) Bureau of Indian Standards, New Delhi.(1985)
9. IS: 2720 – (Part – 8) Method of test for soils : Determination of water content –Dry density relation using heavy compaction (Second Revision) Bureau of Indian Standards, New Delhi. (1983)
10. IS : 2720 –(Part – 13) Method of test for soils : Direct shear test (Second Revision) Bureau of Indian Standards, New Delhi. (1986)
11. IS: 2720 – (Part – 15) Method of test for soils : Determination of consolidation properties (First Revision) Bureau of Indian Standards, New Delhi. (1986)
12. IS: 2720 –(Part – 17) Method of test for soils : Laboratory Determination of permeability (First Revision) Bureau of Indian Standards, New Delhi. (1986)
13. IS: 2720 –(Part – XL) Method of test for soils : Determination of free swell index of soils (Third Revision) Bureau of Indian Standards, New Delhi. (1997)
14. Krystyna M. Skarky~skarzynska , Reuse Of Coal Mining Wastes In Civil Engineering , waste management , Vol. 15, No. 2, pp. 83- 126, Elsevier Science Ltd (1995)
15. Poulsen , B. , Khanal,M. Rao, .A. M. et al. , Mine Overburden Dump Failure: A case Study , 2016 Geotechnical and Geological Engineering April 2014 Vol 32 issue 2 , pp 297-309 (2016).