STUDY AND ANALYSIS OF FLY ASH FOR STOWING IN UNDERGROUND COAL MINE VOIDS

Dr. H. K. Naik*, **Dinesh Reddy Pappu**†

*Associate Professor, National Institute of Technology, Rourkela, Odisha, Pin-769008
† Student, National Institute of Technology, Rourkela, Odisha, Pin-769008
Corresponding author's email: hknaik@nitrkl.ac.in
Corresponding author's Ph. No.: +91-9937115419

Extended Abstract

About 73% of the India's total installed power generation capacity is thermal of which coal-based generation is 90%. Around 85 thermal power stations, besides several captive power plants use bituminous and sub-bituminous coal and produce large quantities of fly ash. High ash content (30% - 40%) coal contributes to these large volumes of fly ash. The country's dependence on coal for power generation has never gone down. The term "fly ash" is used to describe any fine particulate material precipitated from the stack gases of industrial furnaces burning solid fuels. The amount of fly ash collected from furnaces on a single site can vary from less than one ton per day to several tons per month. The characteristics and properties of different fly ashes depend on the nature of the fuel and the size of furnace used. A cause of concern for the future is fly ash management. We have a lot of avenues for use of fly ash, yet we have not yet achieved 100 percent utilization of fly ash generated from coal based thermal power plants resulting in accumulation in ash ponds near the plant and creating environmental hazards to local community. Production of fly ash relies on the coal source, plant activities and numerous more factors. In the present study lime was added with fly ash to gain strength of fly ash to be placed in mine voids for filling purposes. Research facility tests were carried out in our laboratory to assess the strength gain in the fly ash by adding lime to it. Standard proctor hammer test, unconfined compression test, and tri-axial test were carried out to decide about its suitability for placement in mine voids where large amount can be utilized releasing a great stress to the environment. From the results of laboratory study using lime as an additive to the flyash encouraging properties are obtained for filling it in mined out areas. The aim of this study was to find a suitable utilization avenue for a particular fly ash sample depending upon its geotechnical properties and thus reduce the need for vast areas for disposal of fly ash which in turn causes considerable damage to the environment in the form of particulate matter in summer season. By filling these waste materials in underground mine voids this perennial problem of environmental hazard can be addressed suitably.

Key words: *fly ash, coal mine voids, characterization, lime*

1. Introduction

Ground subsidence is a very common phenomenon that is being observed in many coal mining areas. It is caused due to large underground mined out space left out after mining operations have been done. The ground equilibrium will be disturbed as soon as the excavation is done with different forces acting on it. Mine subsidence is the manifestation of gravitational action on strata. Backfilling or sand stowing has been used as a method of filling the voids for decades to counter the effect of subsidence and to improve the pillar recovery. Waste rock, mill tailings, quarried rock, sand and gravel are some of the common types of materials used for backfilling. Later it has been observed that sand or mill tailings tend to remain loose as backfilling material and merely serve as a temporary working platform and do not offer any lateral stress on the opening walls to

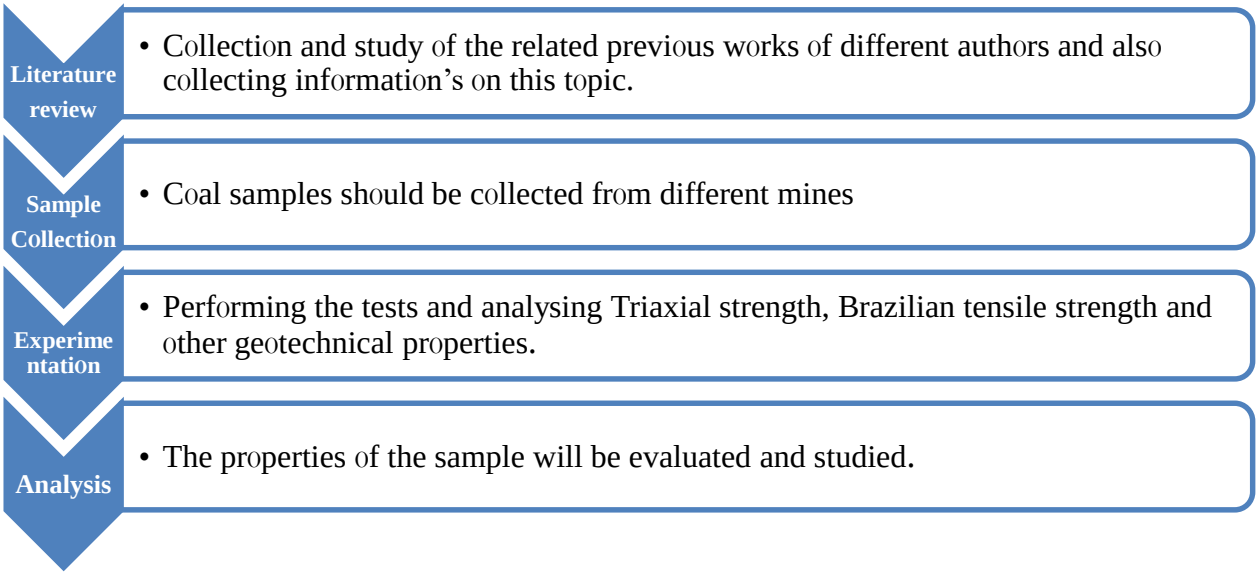
improve the stability situation. Due to the high cost of cemented backfills which cost around 10%-20% of the total operating cost of the mines with 75% of that cost taken by cement and also due to the unavailability of river bed sand, the use of fly ash (a by-product of coal based thermal power plants) as the alternative material has been tried to replace the conventional depleting river bed sand. It is an environmentally sound process and is the most feasible option for bulk utilization of fly ash. Using fly ash for filling the voids will save enormous land requirement for ash disposal in ash ponds which is a major issue now all over India. It fills well into the void/cavity as it can easily flow because of its better flowability properties compared to river bed sand.

2. Formulation

The aim and primary objective is to reduce the problem of subsidence so as to protect the surface features by mine void backfilling as well as effective utilizationof fly ash. The specific objectives to meet the goal were the following.

- Characterization of fly ash.
- Determination of physical and chemical properties of fly ash composite material.
- Development of composite materials with fly ash and lime.
- Determination of geotechnical properties such as, Unconfined Compressive Strength (UCS), Brazilian Tensile Strength (BTS) etc.

Following steps were followed in order to complete the project in a sequential way:



3. Result

The following fly ash Sample is collected from captive power plant **(CPP), National Aluminum Corporation (NALCO),** Talcher, Angul District of Odisha.

Table 1: Moisture content of the collected fly ash

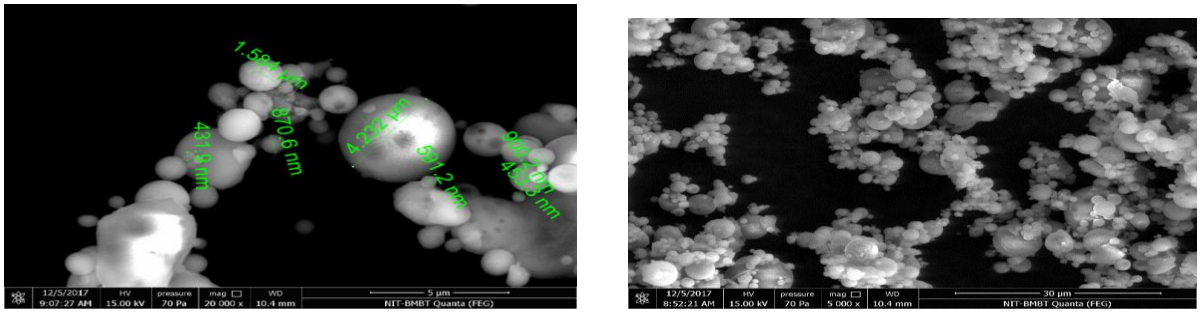
Sl. n0	X in gms	Y in gms	Z in gms	Y – Z in gms	Y – X in gms	M0isture Y –Z/Y –X %
01	34.0557	35.0583	35.0583	0.0021	1.0026	0.209%

Table 2: Density of the collected fly ash

SL. N0.	Am0unt 0f fly ash taken (gm)	Initial reading in (ml)	Final reading in (ml)	Difference in (ml)	True Density in (gm/cc)
1	20	*200*	*210*	10	*2*
2	20	*220*	*230*	10	*2*
3	20	*180*	*190*	10	*2*

Table 3: Permeability of the collected fly ash

Sl.no	Average discharge (Q) ml	Length of specimen in cm (L)	Areaof cross section (A) in cm^2	Time in seconds (t)	Head constant (H)	Coefficient of permeability KT =QL/AtH
01	5.6	10	78	300	6	$3.98*10^{-4}$ cm/sec



Figur

e 1: Scanning electron micrographs of the collected fly ash sample

4. Conclusion

The above discussed project has been done to analyze the utilization of fly ash, obtained from the NALCO power plant, for filling underground voids in mines. As per the different tests conducted such as Shear strength, Proctor compaction test, Uniaxial compressive strength test, Permeability test, Moisture Content, True density, Scanning Electron Microscope analysis the following conclusions are drawn: This Fly ash belongs F class, It has very less CaO% (< 10%), The moisture content of the sample were found out to be around 0.209% indicating that all the moisture have been evacuated and they are suitable for the void filling etc. It has an ideal true density; strengthening of composite is due to dispersion strengthening, particle reinforcement and solid solution strengthening. During our personal assessment, we have observed that fly ash composites with 10%, 20% and 30% lime added to it did not show much tensile strength even for a basic setting load. But fly ash composite with 40% lime showed some strength which can be used for filling mine voids.

5. References

(1) Jirina, T., Jan, S., 2010, Reduction of surface subsidence risks by fly ash exploitation as filling material in deep mining areas, Natural Hazards 53, 251-258.

(2) Mishra, D., Das, S.K., 2010. A study of physico-chemical and mineralogical properties of Talcher coal fly ash for stowing in underground coal mines. Materials Characterization 61, 1252-1259.

(3) Bulusu, S., Aydilek, A.H., Petzrick, P., Guynn, R., 2005. Remediation of abandoned mines using coal combustion by-products, J. Geotech. Geoenviron. Eng. 131, 958-969.

(4) Bulusu, S., Aydilek, A.H., Rustagi, N., 2007. CCB-based encapsulation of pyrite for remedial of acid mine drainage, J. Hazard. Materials, doi: 10.1016/j.jhazmat.2007.01.035.