International Journal for Modern Trends in Science and Technology
Volume: 09, Issue No: SI02, March, 2023
ISSN: 2455-3778
http://www.ijmtst.com

SUBSIDENCE ANALYSIS ON THE PERFORMANCE OF THE FLYASH

A. AKHIL KUMAR[1] | V. SAI[1] | T. MARUTHI[1] | V. MAHESH[1] | PRAKASH S[1]

[1]Department of Mining Engineering, Godavari Institute of Engineering and Technology(A), JNTUK, Kakinada, Rajahmundry, Andhra Pradesh, India

To Cite this Article
A. Akhil Kumar[1], V. Sai[1], T. Maruthi[1], V. Mahesh[1], Prakash S[1]."SUBSIDENCE ANALYSIS ON THE PERFORMANCE OF THE FLYASH", *International Journal for Modern Trends in Science and Technology*, Vol. 09, Issue SI02, March 2023, pp.-01-05.

ABSTRACT

This project is to understand the physical, mechanical and chemical properties of fly ash. fly ash is versatile engineering material which is being utilized effectively in civil, mining & agricultural sectors in order to reduce the open dumping of fly ash which causes severe air pollution etc. Fly ash is used as a stowing material in underground mines, so it's essential to have a clear knowledge about the subsidence behavior of fly ash in relation to the traditional sand stowing. Fly ash was tested for the compression behavior under dry conditions in a pit. The observations are recorded frequently, later on stress analysis was performed using ANSYS workbench2023 software. Equivalent stress and total deformation test was conducted under varying load. XRD test was also conducted on the fly ash sample. It is observed from the experiment that fly ash is having more yielding behavior so excessive precautions should be taken in order to control the subsidence over the ash stowing.

KEYWORDS: ***Fly ash, subsidence, physical, mechanical properties, XRD test***

I. INTRODUCTION

The demand for power generation has increased to fulfil the necessity of humans. Coal is the leading resource material for power generation in thermal power plants. In India, coal is mostly used for thermal power generation, which accounts for over 69% of the country's total power generation [1]. The generation of fly ash is increasing as the power supply demand increases. The research on utilization of fly ash had been studied by the researchers throughout the years, and their suggestion had been implemented in a different industry.Subsidence is a time-dependent process, either natural or man-induced, in which there is a lowering of the ground surface in response to the removal of gas, liquid, or solid matter. [2].The stable subsidence reduction rate by Backfilling in Separation (BIS) is **35%,** and the occurrence of the maximum subsidence rate is delayed, so BIS effectively contributes to the reduction of ground subsidence and subsidence. [3].In this article, tests have been conducted simultaneously on ash and sand to observe relative settling velocities and appropriate conclusions has been drawn. Researchers have conducted the subsidence analysis in consideration with graphical-profile function, Influence function, Numerical modelling and Empirical method [4].A mixed material with a gangue to fly ash ratio of **1: 0.35** was backfilled into the underground goaf. This process allows us to safely dispose of approximately **3.0084×10^6 tons** of solid waste annually. After the demolition of the backfilled walls, the maximum surface settlement was only **170 mm**, well below the level of extreme deformation normally considered necessary to damage surface buildings. Backfill mining of gangue and fly ash mixtures is an effective and environmentally

friendly mining method in coal mines [5].It is observed that people could walk freely over the pond ash bed within half an hour of stowing in PK No.1 incline mine, manuguru area, Singareni collieries Co. Ltd. Water seepage through the barricade is good [6].Surface subsidence investigations were carried out in the 16.5 m thick seam at the Hindustan Lalpeth No. 1 mine in the Wardha Valley coalfield. The width-to-depth ratio was **2.9: 1**. The height of the excavation was **10.45**m. The maximum drop was only **0.9** percent of the total mining thickness. The residual settling was **16.4 - 21.4 %.** The angle of draw: **170-360**. The time factor was about **200** days after an extraction. The volume of the subsidence trough was **0.67%** of the volume mined underground. The maximum slope, compressive and tensile strains were **3.2 mm/m, 1.6 mm/m, and 1.7 mm/m** respectively. Subsidence movements did not affect surface topography or vegetation [7].

II. METHODOLOGY

The experiment started with a subsidence Comparison which includes observations of the subsidence of fly ash (Vijayawada thermal power station) and sand (Godavari River bank sand) in this Comparison weights added to the fly ash and sand are equal. Our experiment is a kind of lab model. we didn't develop any opening under the filled material. we have to know about the performance of fly-ash and sand when we added the load on it. The step wise procedure to be followed during the fly- ash and sand process are as follows:

1. The pit which was dug and trimmed to have perfect edges and equal volume.
2. The pit dimensions are 0.90m×0.45m×0.5m equal at both sections and fill the fly ash and river sand separately.
3. As the volumes remained the same but the sp. gr is different from fly ash to sand (as shown in the table.)
4. It took 438 kg of fly ash to fill the pit of dimensions 0.90m×0.45m×0.5m and 526 kg of river bank sand to fill the pit of the same dimensions.
5. To have a clear distinction between the previous reading and subsided reading we made use of glass as a wall.
6. Later top up a load on both the sections till 75 days time factor every single time we added 4.5kg of excess weight to both the material.
7. The readings are recorded at predetermined intervals, manually using a VERNIER scale with a least count of 0.1 mm. The fly ash readings are shown in the following Table 4.
8. Proper arrangements are made and precautions are strictly followed during the full course of the experiment, fencing walls are erected and a sophisticated shelter was constructed around the experiment.

III. RESULTS AND DISCUSSION.

A. PHYSICAL PROPERTIES

1.Color

The colour of fly ash which obtained from five different sources with each Fe O contents. Greyish white.

2. Optimum moisture content

2.1. Proctor test

Optimum soil moisture is determined in the laboratory by performing the Proctor test. The Proctor test is a test to determine the maximum unit weight to which soil can be compacted. There are two types of Proctor tests, standard Proctor tests and modified Proctor tests.The optimum moisture content of the fly ash is 22%.

3.Natural density

Density is the key factor underpinning such calculations and this varies not only due to geology, and specifically coal rank, type and grade, but also to the method used for its measurement. It plays a major role in the estimation of reserves and in the beneficiation process because density is the primary separation medium utilized in coal beneficiation. Coal plies and particles have different relative densities and physical properties, as determined by their maceral composition, rank, mineral (ash) and moisture contents.The natural density of our fly ash is 2.16 (g/cm^3).

4.Specific gravity

The specific gravity of fly ash usually ranges from 2.1 to 3.0, while its specific surface area (measured by the Blaine air permeability method may range from 170 to 1000 m2/kg.The sp.gr of this fly ash is 2.164

5.Loss on ignition Many state departments of transportation specify a maximum LOI of 3% or maximum 4%, even though the ASTM standard is a maximum LOI of 6%. This is because carbon levels above 3% to 4% (reflected by the LOI) negatively affect the air. The LOI of this fly ash is 2.74

6.Coefficient of permeability

Fly ash reacts with available lime and alkali to produce additional cementitious compounds which can block permeable channels, fill pores and reduce the permeability of hardened concrete. The pozzolanic

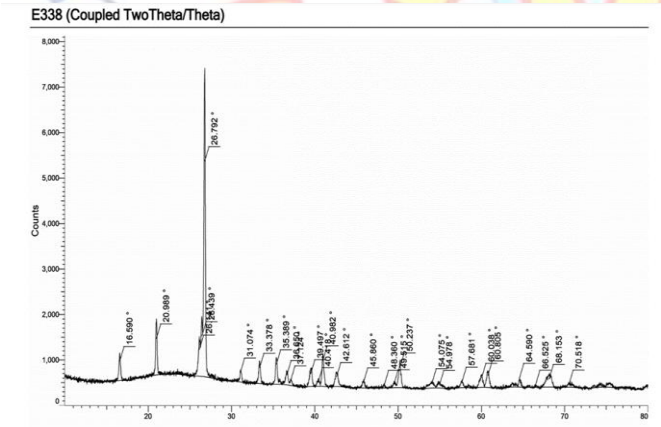

Fig 1: XRD TEST RESULTS

reaction consumes leachable calcium hydroxide (Ca(OH)2) and replaces it with insoluble hydrated calcium silicate (CSH). The increase in the volume of fines and the decrease in water content also played a role. The Coefficient of permeability, k×10−4 (cm/s) of this fly ash is 1.42

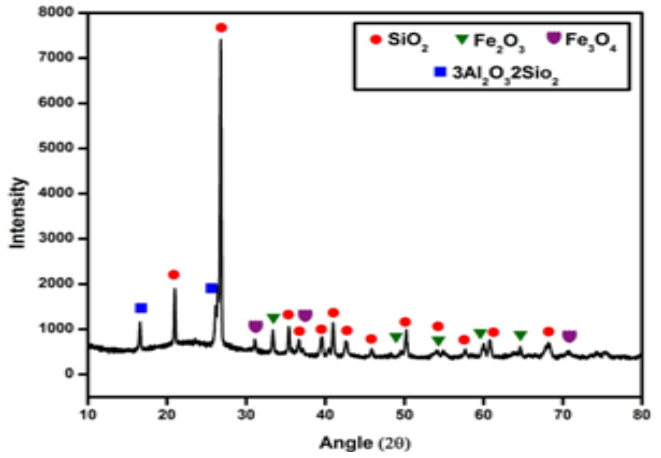

Fig 2: SIMPLIFIED XRD RESULTS

7.Water holding capacity

The water holding capacity of fly ash from different thermal power plants in eastern India was compared. In addition, the effect of particle size (sieving) on water holding capacity was determined. The rate of desorption of water retained by the fly ash fraction at room temperature (25–30°C) was studied. The water holding capacity of this fly ash is 53.51 %

8.Shape and size

Fly ash is generally finer than Portland cement and lime. Fly ash consists of generally spherical, silt-sized particles, typically between 10 and 100 microns in size (Figure 1-2). These small glass beads improve the flow and workability of fresh concrete. Fineness is one of the important characteristics affecting the reactivity of fly ash pozzolans. Fly ash generally has a particle size between less than 1 μm and 150 μm, generally finer than portland cement. Fly ash has also been reported to consist primarily of silt-sized material with particle sizes ranging from about 100 microns to submicron.

B.XRD test

The XRD patterns of the fly ash of VTTP are shown in Figs. From the diffractograms it is clear that they have similar diffraction patterns. The XRD patterns of the fly ash samples have peaks characteristic of (SiO2), mullite (3Al2o3 2Sio2) and iron oxides such as hematite (Fe2O3)-H and magnetite (Fe3O4)-Ma which occur in crystalline form. However, the most common phases and minerals found in these ash Samples include quartz and mullite. Quartz may be considered as the primary mineral present in all the Ash samples and indicated by sharp peaks in the diffraction patterns. In all the ash samples, the most Intense peak near 2θ= 26.792 ° is identified as the main peak due to quartz. Mullite mineral is present in all the ash sample and the peak near 2θ= 26.439 ° is identified as mullite. The presence of heavy Minerals like hematite and magnetite are indicated by their respective peaks near 2θ= 33.379 ° and 2θ= 31.074 °.

C.2d model

This 2D model depicts the initial and final states of our fly ash model with respective the load acting and subsidence occurred. The actual lengths of the pit is 0.9*0.5*0.45. the load are made of tiles which are 4.5 kg each total No.of tiles loaded on the fly ash was 12 in term of load is 63 kg. The final subsidence was 0.0189m for the total time factor of 75 days

Where: Wh = weights height

H1 = height of actual fly-ash

H2 = fly ash height after subsidence

Sub= subsidence

D.Regression analysis

This figure represents the subsidence vs load acting on the fly ash model. we also plotted the regression line R^2 =0.9778. The trend of the graph initially raised and went flat at thefinal. As the compression increased the density also increased and the subsidence was restricted This figure 5 represents the subsidence vs time taken in days

the regression line R^2 = 0.9727

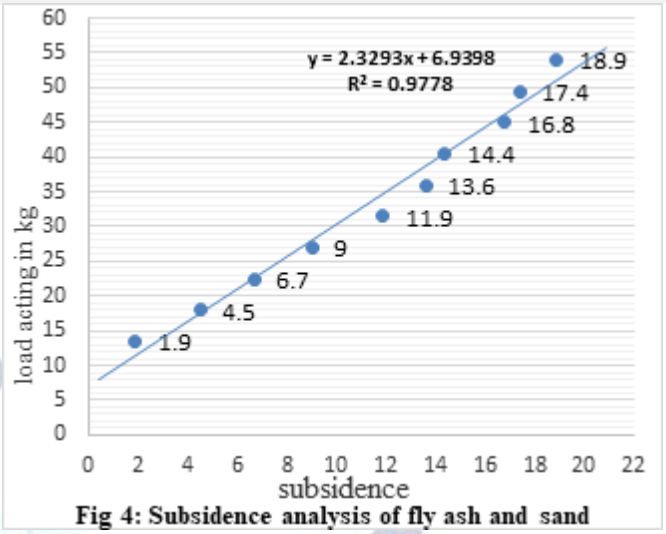

Fig 4: Subsidence analysis of fly ash and sand

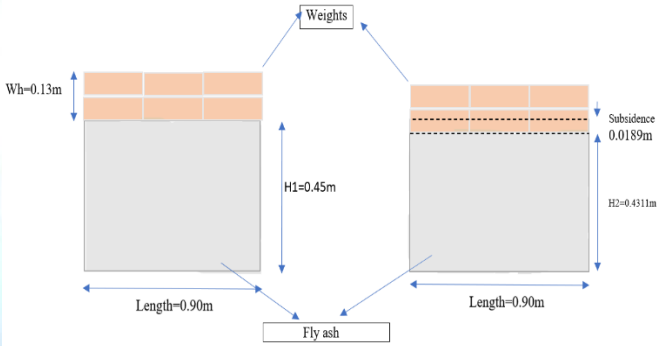

Fig 3: The above figures represent about the initial stage to final stage time lapse (which is 75 days) subsidence analysis of fly ash. At the time of 75nd day the subsided measured height is 0.0189m.

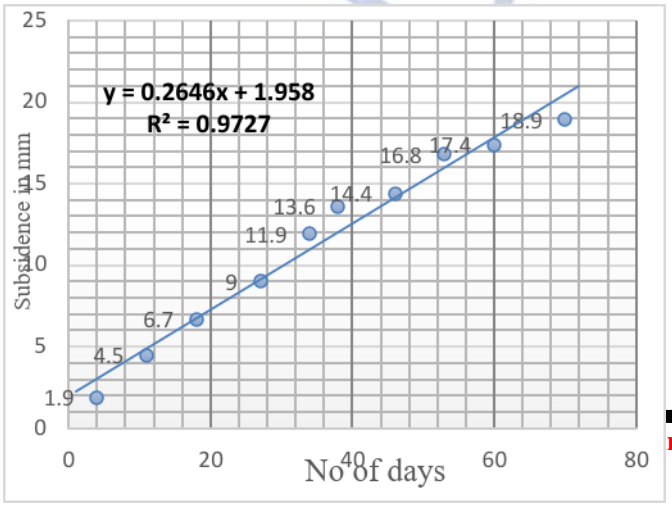

Fig 5: Time lapse of subsidence of fly ash

IV. CONCLUSION

In this paper the physical, mechanical & XRD properties of fly ash was furnished with proper tests and evidences. Subsidence analysis was also conducted on the fly ash and the observations are recorded frequently in a table (table 1) using the data collected from the subsidence analysis stress analysis was also performed on the fly ash model in Ansys workbench2023 software specially meant for solid works and stress analysis, in order to have good knowledge about the induced stresses in our fly ash model.This project can help the researchers to have a basic knowledge about the fly ash and its properties especially the subsidence behavior of it, at what range the fly ash get subsidence and how the stresses induce in it etc.The scope of utilization of fly ash in the underground voids stowing was also discussed so that one can choose this fly ash accordingly It is observed that fly ash having more yielding

behavior and can leads to critical, supercritical subsidence when majority of stowing material is fly ash.

REFERENCES

[1] Central electricity authority, civil design division, New Delhi, (august- 2022). Report on fly ash generation at coal/lignite-based thermal power stations and its utilization in the country for the year 2021 – 22.

[2] F. T. Lee and J. F. Abel, Jr. (1983). Subsidence from Underground Mining Environmental Analysis and Planning Considerations

[3] Yue Jiang, Rafal Misa, Anton Sroka, Yan Jiang (31 may 2020). Mitigating Land Subsidence Damage Risk by Fly Ash Backfilling Technology: An Injection Case in Overburden of Coal Mining by

[4] Kewal kohli, Stefanie self (05/17/2017). Chapter: 8 subsidence prediction methods

[5] Meng Li, Jixiong Zhang, Ailing Li, Nan Zhou (11 Jan 2020). Reutilization of coal gangue and fly ash as underground backfill Materials for surface subsidence control by

[6] Kumar, V; Ahuja, B P; Dattatreyulu, J V (July 01 2003). [Relation: Conference: 3. International conference on fly ash utilization and disposal, New Delhi (India), 19-21 Feb 2003

[7] Singh, K. B., Saxena, N.C., and Jethwa, J.L (1992) Subsidence Studies due to Extraction of a Thick seam with Hydraulic sand Stowing a case history. Indian Mining & Engineering Journal, 31 (4). Pp. 11-16. ISSN 0019-5944 http://cimfr.csircentral.net/id/eprint/790Journals style)," *IEEE Transl. J. Magn.Jpn.*, vol. 2, Aug. 1987, pp. 740–741 [*Dig. 9th Annu. Conf. Magnetics* Japan, 1982, p. 301].