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Study of electrical and thermal conductivity of Flyash

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Abstract: *Flyash, that is a major problem of disposal in India, is a residue that results from the combustion of ground or powdered coal. Its utilization in concrete as partial replacement of cement is gaining importance day by day. This study discusses characteristics of Fly ash as resulted from X-ray diffraction process. The study shows how it can be utilized in an efficient manner. Flyash pellets (made by providing thermal heating at 800°C), a new generation solution. This pellet can be used as a replacement of coarse aggregate in the concrete mixture. This will reduce the self weight of concrete and can also reduce the building cost upto 5-10% than the cost by using normal aggregate.*

Keywords : *Thermal Conductivity, Flyash pellets, XRD, Domains.*

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Introduction:

In recent years much effort has been done in order to find the best way to use different kinds of waste materials for the production of the lightweight aggregates (LWA) and lightweight aggregate concrete (LWAC) for the reasons such as to reduce production costs by replacing natural materials with byproducts or to re-use waste materials instead of putting them into the landfill, One of the most used by-products in the production of LWA and LWAC is Flyashes, generated worldwide from thermal coal-fired powers.

Ash is fine, glass- like, spherical shaped and heterogeneous in nature whose size varies 0.01-100 g recovered from the gases of burning coal during the production of electricity in thermal power

plants. Flyash commonly resembles to volcanic ashes, which were used for the production of earliest known hydraulic cements about 2,300 years ago. It is the best known, and one of the most commonly used pozzolans (a broad class of siliceous or siliceous and aluminium materials) in the world.

These micron-sized earth elements primarily consists of silica, alumina and ferrous (Quan and Kasami, 2014). The mineralogy and composition of fly ash varies from one sample to next depending on the source of the coal, degree of coal preparation, cleaning and pulverization, design, type and operation of the power plant boiler unit, conditions during combustion, additives used to assist combustion or improve precipitation performance, efficiency of emission control devices, storage and handling of the by-products, and the prevailing climate.

Materials and Method:

The requirements for the experimental setup were Flyash, Thermometer, Mould, Heating Plate, Pellet Maker, Impedance Analyzer.

Brick making – The flyash was crushed and then sieved to get its fine powder- sized particle. With the help of so-obtained powder, brick was made with some holes in it. By placing brick's one end at higher temperature and other at lower temperature (such that its one end gets cold and other get heated). Some water was put into the brick's hole to measure its temperature with the help of thermometer. This helped in the study of thermal and electrical conductivities (Bentz et. al., 2011).

Fig. 1. Brick using Flyash

Pellets making – Some pellets were made using the Flyash in a die punching machine under 800°C and silver coating was done on it to study its properties.

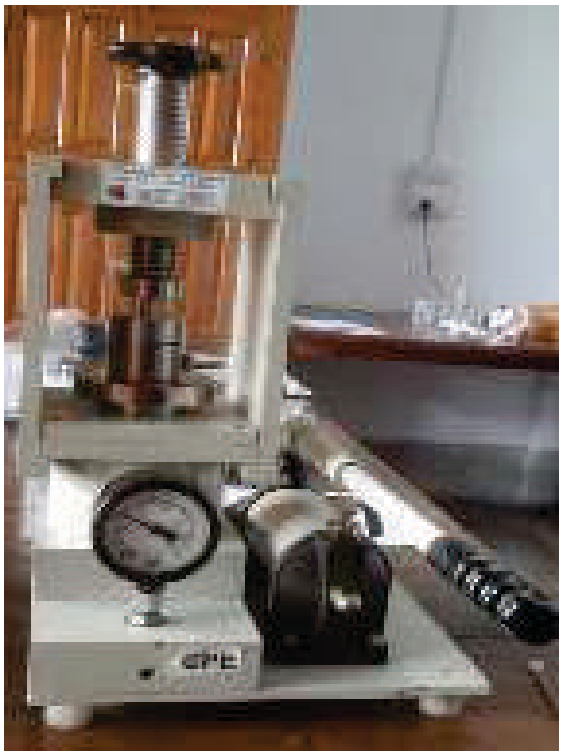

Fig. 2. (a) Die punch for Pellet making.
(b) Pellets of flyash after drying in Furnace

Characterisation technique of fly ash:

The flyash was analyzed using the method of X-Ray Diffraction (XRD) carried out in an XRD machine, which is used to determine the atomic and molecular structure of a crystal, in which the crystalline structure causes a beam of incident X-Ray to diffract into many specific directions.

By measuring the angles and intensities of these diffracted beams, a crystallographer can produce a 3D picture of the density of electrons within the crystals. From this electron density, the mean position of the atoms in the crystal can be determined as well as their chemical bonds, their crystallographic disorder and various other information can also be determined.

XRD analysis is based on constructive interference of monochromatic X-Rays and a crystalline sample which was prepared.

The X-Rays are generated by a Cathode Ray Tube and is filtered to produce monochromatic radiation which is then collimated to concentrate and directed towards the sample. The interaction of the incident rays with the sample produces constructive interference and diffracted rays when conditions satisfy Bragg's law i.e. $2d \sin\theta = n\lambda$ which relates the wavelength of electromagnetic radiation to the diffraction angle and the lattice spacing in the crystalline sample.

Results and Discussion:

Flyash is a complex mixture of inorganic compounds similar in characteristics to certain vitreous insulating materials which in the pure state have high electrical resistivities of the order of 10^{14} to 10^{15} ohm-cm. (Jo et al., 2007, Joshia et al, 2020). The conductivity of flyash for temperatures below about 550° F depends basically on the presence of moisture and of certain chemical impurities in the gas which are adsorbed on the particles.

The brick on putting ice in its hole, absorbs the melted ice very quickly.

The results from XRD are shown in the Fig. 3.

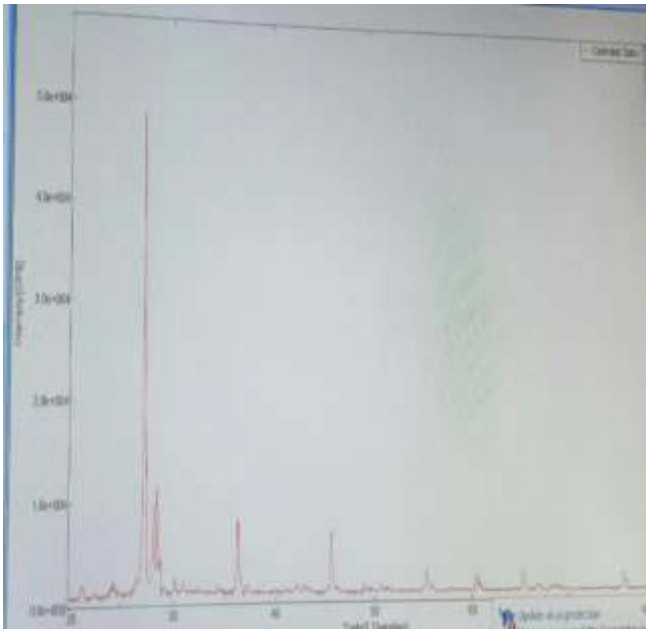

Fig. 3. Result from XRD analysis

XRD analysis is based on constructive interference of monochromatic X-rays and a crystalline sample: The X-Rays are generated by a cathode ray tube, filtered to produce monochromatic radiation, collimated to concentrate, and directed toward the sample. The interaction of the incident rays with the sample produces constructive interference (and a diffracted ray) when conditions satisfy Bragg's Law (n=2d sin). This law relates the wavelength of electromagnetic radiation to the diffraction angle and the lattice spacing in a crystalline sample. The characteristic x-ray diffraction pattern generated in a typical XRD analysis provides a unique “fingerprint” of the crystals present in the sample (Shanmugasundaram et al., 2010).

The particle size was calculated at different wavelengths using Scherrer Formula

$$\tau = \frac{K\lambda}{\beta \cos\theta}$$

Where;

Ƭ is the mean size of the ordered (crystalline) domains, which may be smaller or equal to the grain size, which may be smaller or equal to the particle size.

K is the dimensionless shape factor and has a typical value of about 0.9.

λ is the x ray wavelength.

β is the line broadening at half the maximum intensity, after subtracting the instrumental line broadening, in radiance. This quantity is sometimes denoted as 2θ. θ is the Bragg angle.

Conclusion:

From the present study, we can conclude that the flyash can be utilized efficiently in making bricks only when the brick is made under high pressure and the utilization of this brick can be at various places, for instance it can be used in the path made in gardens of parks since it can soak the water in a quick manner.

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