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Review Article

Fly ash – A future material

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A R T I C L E I N F O

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A B S T R A C T

Now a day's fossil fuel is the need of the entire world. Fossil fuel generation is accompanied with the production of fly ash. Fly ash is the lighter residual particles given after the combustion of the coal. The fly ash contains oxides of metals like iron, aluminum, silicon, magnesium, titanium etc. Silica and alumina are the major constituents which enhance the applicability of fly ash in making of floor tiles, compound sheets, bricks and also in cement production. Certain types of fly ash exhibit cementisious property of hardening on exposure to moisture. Silica being glass former the fly ash can also be used in glass making in place of silica. Fly ash is the bye product of coal combustion and needs to be recycled into value added products. Department of Science and Technology has special Fly Ash Mission for promotion of utilization of fly ash. Fly ash composites were prepared and the compressive strength was measured. The compressive strength measurements are essential so as to develop the composite to be used as floor tiles.

K E Y W O R D S

Fly ash | Silica | Alumina | Composites | Physical properties

C I T A T I O N

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Introduction

Fossil fuel is very widely used all over the world. Electrical energy is generated by burning of fossil fuel *i.e.* coal. The burning of coal gives thermal energy and also produces ash as a bye product. The ash is of two types, 1 fly ash and 2 bottom ash.

Fly ash particles being lighter are given out through the high rise chimneys and the electro static precipitator collects the particles in ash ponds/ it is collected in filter fabric collector in dry mode (Mandal Pradip Kumar and Tanuj Kumar, 2006). Bottom ash as the name suggests, they are heavier particles given out from the bottom of the chimneys of the thermal power plant. The fly ash is produced in very large volume and the heaps of it accumulate on the land and if not utilized becomes a threat to the environment. Scientists, researchers, physicists, chemists are working on the suitable and fruitful utilization of the fly ash into value added products. Here an attempt is made to prepare a composite of fly ash and develop it as tile.

Fly ash composites were prepared by suitably compounding it with other chemicals. The compressive strength of the composite is measured from the point of view of checking its use as a floor tile for house hold purpose. This will boost up manufacturing and business opportunity for local people and help utilization of the fly ash in environment friendly manner.

Methodology

The grade F fly ash used in this work was collected from the thermal power plant at Khaparkheda, Nagpur, India.

The fly ash was compounded with sodium hydroxide and lime in a proportion 3: 1: 2 i.e. 3 parts fly ash was compounded with 1part sodium hydroxide and 2 parts lime. All the ingredients were mixed thoroughly and the mixture was cast into moulds of suitable shape (circular or rectangular). The compound was made into circular discs using mould and by applying pressure in a Hydraulic press. The discs were dried for two days and then cured in water for fourteen days and again dried for three days. Samples were prepared by applying different pressure keeping rest of the procedure of drying, curing and drying same. The compressive strength was measured for these samples as a function of applied pressure.

Characterization technique

The fly ash was subjected to chemical analysis. The analysis was done at the Anacon Laboratory, Nagpur. The chemical analysis is done to confirm the presence of metal oxides in the fly ash and to know their percentage. For checking the viability of the samples to be used as tiles, it is essential to measure the compressive strength of the samples. Compressive strength is the capacity of a material to withstand loads tending to change its dimensions. It can be measured in universal testing machine as function of applied force against deformation. These measurements were done in Universal testing machine at VNIT, Nagpur.

Result and Discussion

The mineralogy of fly ash is very diverse. It is a heterogeneous material and mainly depends upon the coal type used in the combustion. Silica, alumina, iron oxides are the main oxides present in the fly ash. The chemical analysis report is presented in Table 1.

The reactivity of fly ash depends on its fineness, percentage of reactive silica present in it (Joshi and Kadu, 2012). The oxides of silica, aluminum and iron exhibit a property to form cementicious solid when reacted with alkalis like potassium or sodium hydroxide. This property is called as pozzolanic property and is used here to prepare the composites (Joshi and Kadu, 2012).

Compressive strength is defined as the ability of a material to hold maximum loads tending to change its dimension. Here in this work compressive strength of the samples is measured as a function of pressure applied by the hydraulic press while preparing the samples in the moulds. The results of the compressive strength as a function of applied input pressure are presented in Table 2.

Table 3 shows the compressive strength of materials commonly used in construction (Jatale and Tiwari, 2013). From Table 2 it is seen that the compressive strength increases almost linearly with applied input pressure. The applied input pressure increases the compactness of the composite. Due to increased compactness of the composite the volume shrinks and the density increases. The increase in density imparts strength to the composite thereby results into increase in load bearing capacity or load withstanding capacity of the composite.

Comparing Table 2 with Table 3, the compressive strength of the fly ash composites is comparable with the compressive strength of lime stone and sand stone. It exceeds the compressive strength of light and heavy bricks and brickwork. The composite in tile form can be very good replacement for the floor tile as well as external wall structure, if the composites are made into rectangular sheets.

While preparing the fly ash composites, the samples were cured in water for fourteen days. The water in which the composites were cured might be harmful due to leaching of hazardous chemicals from fly ash. Thus the water remaining after curing procedure was subjected to chemical analysis at Anacon Laboratory, Nagpur. Table 4 shows the results of chemical analysis. From this table it is clear that the leaching liquid i.e. water does not contain arsenic, mercury or lead hence it can be safely disposed off. Further it was found to contain 45% sodium oxide The residual water could be used to recover sodium hydroxide. This would further help to reduce the cost of production

The procedure of preparation is simple and does not require any heavy machinery. An industrial mixer and a hydraulic press are the minimal requirements for preparing these composites. The thermal power plants are providing ample fly ash at very minimal rates. The other two requirements are of the lime and sodium hydroxide. If this composite tile making is taken on mass scale it can be very well and effective utilization of the fly ash and that too in environment friendly manner. The tiles could be used for low cost housing projects. The tile making unit would be able to provide good source of income with minimum input and also provide employment to needy people. It is very good solution with the environmental friendly utilization of the fly ash.

S. No.	Composition	Volume %
1	Silica	55.81
2	Aluminum Oxide	25.41
3	Iron Oxide	9.35
4	Titanium Oxide	0.28
5	Manganese Oxide	0.21
6	Magnesium Oxide	1.18
7	Calcium Oxide	1.28
8	Sodium Oxide	1.28
9	Potassium Oxide	0.96
10	Loss on ignition	1.82

Table 1: Composition of fly ash (Anacon Laboratory, Nagpur)

S. No.	Input Pressure in ton	Compressive strength in N/mm^2
1	10	21.972
2	12	17.56
3	13	49.853
4	14	53.809
5	15	54.403
6	16	52.252
7	17	74.299
8	18	74.33

Table 2: Compressive strength composite as function of applied pressure

S. No.	Material	Compressive strength in N/mm^2
1	Bricks	8
2	Bricks light	7
3	Brickwork	7
4	Granite	130
5	Limestone	60
6	Portland cement	43
7	Sandstone	60
8	Slate	95

Table 3: Compressive strength of common building material

S. No.	Test parameter	Test Result Gm/100 gm
1	Silica	1.77
2	Alumina	0.65
3	Iron Oxide	0.14
4	Titanium oxide	0.02
5	Manganese oxide	0.004
6	Magnesium oxide	0.55
7	Calcium oxide	1.45
8	Potassium oxide	0.62
9	Sodium oxide	45.96
10	Arsenic	No traces
11	Cadmium	No traces
12	Lead	No traces
13	Mercury	No traces
14	Moisture	16.26

Table 4: Chemical analysis of residual water

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