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Technical Note

THE EFFECT OF RANDOMLY ORIENTED HAIR FIBER ON MECHANICAL PROPERTIES OF FLY-ASH BASED HOLLOW BLOCK FOR LOW HEIGHT MASONRY STRUCTURES

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Abstract

The main objective of the present work is to study the effect of mixing of hair fiber on mechanical properties of fly ash. The hair fiber was mixed in fractions of 0.00, 1.00, 1.50, 2.00 & 2.50% respectively. Portland cement production is under critical review due to high amount of carbon dioxide gas released to the atmosphere.

Kumar [1] reported that in recent years, an attempt to increase the utilization of Fly ash to partially replace the use of Portland cement in concrete has been gathering momentum. Most of this by product material is currently dumped in landfills, thus creating a threat to the environment. About 82 utility thermal power plants (TPPs) in the country contribute nearly 70 % of total power generation, which in turn, produced 108 million tonne of fly ash during 2004. The annual generation of fly ash is projected to exceed 175 million tonne per annum by 2012 AD.

In this struggle scientists and engineers, especially civil engineers, are playing a remarkable role. A number of studies have been carried out to determine the effect on the physical properties of soil and fly ash with and without Lime. However, very few studies have been done to investigate the effect of randomly oriented hair fiber on fly ash based Hollow block. In this paper, results of an experimental study have been presented to determine the effect of randomly oriented hair fiber on mechanical properties of fly ash based hollow block.

Keywords: Fly ash; hair fiber; compression test; OMC test

1. Introduction

Kumar [1] reported that, Portland cement Production is under critical review due to high amount of carbon dioxide gas released to the atmosphere. In recent years, attempts to

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increase the utilization of fly ash to partially replace the use of Portland cement in concrete are gathering momentum. Most of this by product material is currently dumped in landfills, thus creating a threat to the environment. About 82 utility thermal power plants (TPPs) in the country contribute nearly 70 % of total power generation, which in turn, produced 108 million tonne of fly ash during 2004. The annual generation of fly ash is projected to exceed 175 million tonne per annum by 2012 AD.

According to Dhar [2] there has been impressive increase in the power generation in India from a low capacity of 1362 MW in 1947 to about 112050 MW in 2004. Indian coal has high ash content around 35-45% and low calorific value 3500-4000 K-cal/Kg as a result of which huge quantity of ash is generated. A typical 200 Mw unit produce around 50-60 M. Tons of ash per hour in India. It is expected that capacity of coal based power plant will touch around 160,000 Mw's by the year 2012 AD, and ash generation will reach a figure of around 200 million M.Tons per year.

Mishra [3] says that durability problems of built infrastructure along with environmental implications of widespread use of materials of current choice such as Portland cement concrete are likely to dominate the development of the cement and concrete industry in the next century. The need to control the rate of increase in worldwide greenhouse gas emission is likely to result in regulations leading to substantial changes in the industry in order to ensure long-term sustainable development. Worldwide cement production is likely to be 2 billion tonnes in 1-1.5 tonnes of CO_2 being released to the atmosphere 50% from calcinations of limestone and 50% from the combination of the fossil fuel.

Though the fly ash is being used as a construction material in the manufacture of bricks, hollow block and as partial replacement of cement in cement concrete for many civil engineering projects, but its use as a general fill material on mass scale is not very popular. Its use in embankments for the construction of highways and railways, can serve the dual purpose of its mass utilization and preservation of ecological balance. The Delhi Metro Rail Cooperation (DMRC) has opted such an arrangement in its mass transit system for Delhi.

As reported above, fly ash has great potential for important uses in various sectors, the main utilization being in building and construction industry. To the large extent of fly ash utilization, further studies were also made on the fly ash, which are discussed herewith. Several researchers have hovered their attention towards finding out various properties of fly ash have also reasoned the drift in the values from the normal values of soil.

Sherwood and Ryley [4] reported that most fly ashes contain particles that are predominantly silt-sized with some sand-sized particle. The use of lime to treat fly ash was suggested by Uppal [5]. Dayal [6] also reported low values of specific gravity values of fly ash. The low values of specific gravity are attributed to particles being hollow spheres or cenospherical. Also there are other factors on which specific gravity value depends such as gradation, chemical composition of fly ash, etc.

Sridharan et Al. [7] have reported the shear strength characteristics of some Indian fly ashes under various conditions. Pandian et al. [8] studied the variation of specific gravity of Indian Fly ashes in great detail. Akshaya Kumar Sabat [9] reported that the decrease in liquid limit, plastic limit and increase in shrinkage limit indicate that NALCO fly ash can easily stabilize expansive soil, with percentage increase in fly ash the OMC of the soil decreases though MDD does not vary much, which is due to better gradation of block cotton soil with fly ash. The swelling pressure decreases with the addition of fly ash which is attributed to the decrease in plasticity characteristics due to reduction in clay content of black cotton soil.

2. Experimental Set Up and Procedure

2.1. Material Used

The fly ash used was the portion of the ash collected through electrostatic precipitators of Dadri thermal power station, Dadri (U.P.), India. The physical and Geotechnical properties of fly ash, Hair fiber and the material used in the study are given in Table 2. Because of that coal is supplied from different mines of India the chemical properties also vary a great extent and the results of Chemical analysis of fly ash along with their range for different materials are given in Figure 1/Table 1. The cement used was Ordinary Portland Cement (OPC) of 43 grade. The OMC and MDD of fly ash was done through Standard Proctor's Test or Standard AASHTO (T-99) Test is shown in Figure 2.

Table 1 and Figure 1 Chemical analysis of fly ash along with the range of different materials.

Table 1. Chemical analysis of fly ash along with the range of different materials

Components	Percentage of different component in the fly ash used
SiO_2	51.50
Al_2O_3	20.95
Fe_2O_3	8.50
CaO	5.27
MgO	3.85
SO_3	0.35
Na_2O	0.25
K_2O	0.18
LOI	0.15

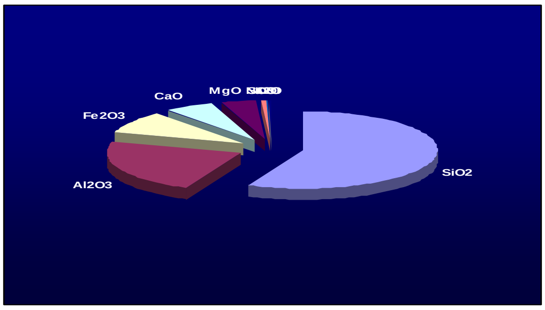

Figure 1. Chemical analysis of fly ash along with the range of different materials

Table 2. The properties of materials

S. No	Materials	Physical properties	Value
1.	Fly Ash	Specific Gravity	1.85 at 28 ^{0}C
		Optimum Moisture Content (Standard Proctor Test)	18.2%
		Maximum Dry Density	1.28*g/cc*
		Coefficient of uniformity, C_u	2
		Coefficient of Curvature, C_c	1.13
		Direct Shear Test	
		Cohesion	0.0
		Angle of shear resistance	27^o
		Permeability	1.3x10^{-5} cm/sec
2.	Hair Fiber	Cross- Section	Circular
		Diameter	17-100µm
		Elongation	1.5 times its dry length
		Length	5-50 *mm*
		Specific Gravity	Nil
		Tensile Strength	Nil
3.	Cement	Normal Consistency	27%
		Initial Setting time	32 *min*
		Final Setting time	360 *min*
		Compressive Strength (1:3 cement sand mortar)	20.0 Mpa(3 days) 29.0 Mpa(7 days)
		Tensile Strength (1:3 cement sand mortar)	2.00 Mpa(3 days) 2.39 Mpa(7 days)
		Compressive Strength (1:3 cement sand mortar +2% Hair Fiber)	19.2 Mpa(3 days) 29.5 Mpa(7 days)
		Tensile Strength (1:3 cement sand mortar +2% Hair Fiber)	1.90 Mpa(3 days) 2.42 Mpa(7 days)
4.	Coarse Aggregate (Coarse Sand) Badarpur	Specific Gravity	2.62
		Water Absorption(30 min)	0.43%
		Fineness Modulus	2.87
		Silt Content	2.43%
5.	Fine Aggregate (Fine Sand)	Specific Gravity	2.64
		Water Absorption(30 min)	0.44%
		Fineness Modulus	2.80
		Silt Content	2.40%

2.2 Determination of OMC and MDD

In order to get the value of OMC and MDD light compaction test according to IS: 2720-VII is done. This test conforms to the specifications of SPCT or Standard AASHTO (T-99) Test. The curve shows OMC & MDD in Figure 2.

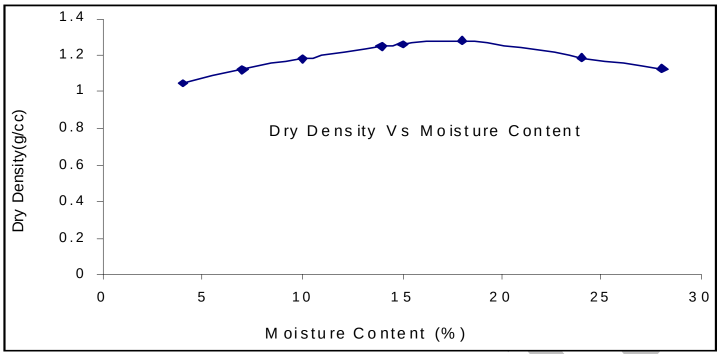

Figure 2. Dry density versus moisture content

3. Preparation of Specimen

For the purpose of determine the compressive strength, hollow block of 9″ x 6″ x 11/2″ size were prepared as shown in Figure 3. The mix proportion for each series is given in Table 3. Three hollow block of each series were prepared to determine compressive strength. The material was weighed dry and placed on a level platform for mixing, fibers were sprinkled gently and mixed dry by using trowel and than the calculated quantity of water was added to the dry mix. Evenly care was taken to prevent agglomeration of fibers and to ensure their uniform distribution as far as possible, the material was poured in three equal layers in the mould of the hollow block. Care was taken to ensure that the fly ash was properly placed and compacted.

Table 3. Mix proportion of different hollow blocks

Hollow block designation	Mix Proportion				Fiber content (%)
	Cement (%)	**FA (%)**	**CA (%)**	**F-A (%)**	
0.00 FRFAM	10	-	-	90	0.00
0.50 FRFAM	10	-	20	80	0.50
1.00 FRFAM	10	05	15	80	1.00
1.50 FRFAM	10	10	10	80	1.50
2.00 FRFAM	10	15	05	80	2.00
2.50 FRFAM	10	20	-	80	2.50

* FA = Fine Aggregate, CA = Coarse Aggregate, F-A = Fly Ash, FRFAM = Fiber Reinforced Fly Ash Mortar.

3.1. Compressive testing of hollow block

The hollow blocks were tested in compression testing machine at 28 days. The loads and corresponding deformations were measure during the test. The specimens for testing are shown in Figure 3. The stress-strain curve of different test series are plotted in Figure 7. It is to be noted here, that each stress-strain curve is the average of three test results. The variation of compressive strength, crushing strain and poisson's ratio with the variation in the percentage of fibers is shown in Figures 8 to 10 and their corresponding values are also given in Table 4. The tested hollow block was under progress shown in Figure 5. The coarse sand and hair fiber used in the experiment are shown in Figures 4 and 6.

Table 4. Test results of different hollow blocks

Designation	**Compressive strength (Kg/cm^2)**	**Crushing strain**	**Poisson's ratio**
0.00 FRFAM	21.33	0.00160000	0.159
0.50 FRFAM	27.58	0.00253333	0.161
1.00 FRFAM	36.33	0.00578025	0.163
1.50 FRFAM	52.50	0.01570275	0.165
2.00 FRFAM	75.56	0.03058650	0.170
2.50 FRFAM	21.50	0.00197798	0.164

Figure 3. Prepared hollow block

Figure 4. Human hair fiber

Figure 5. Test under progress 3

Figure 6. Coarse sand (badarpur)

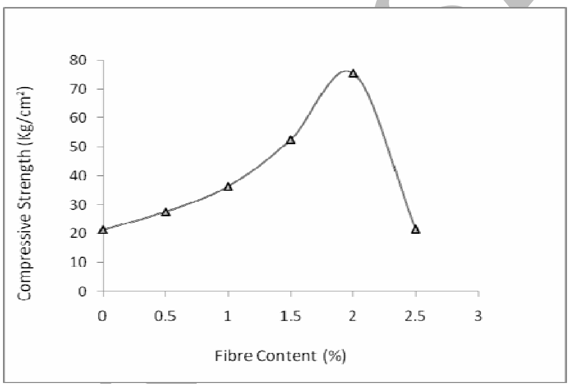

Figure 8. Compressive strength variation

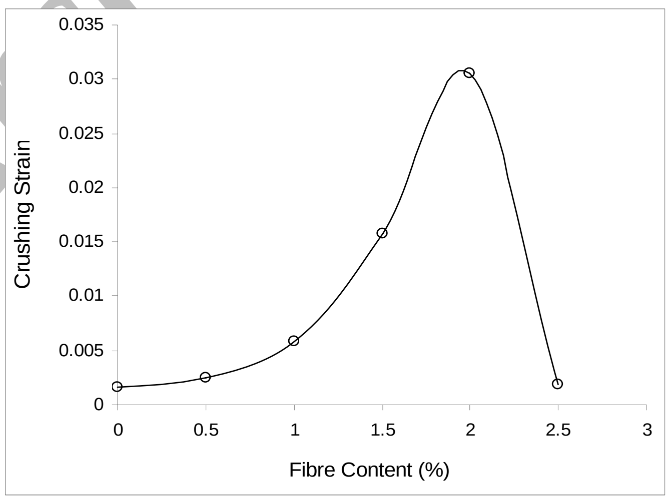

Figure 9. Crushing strain variation

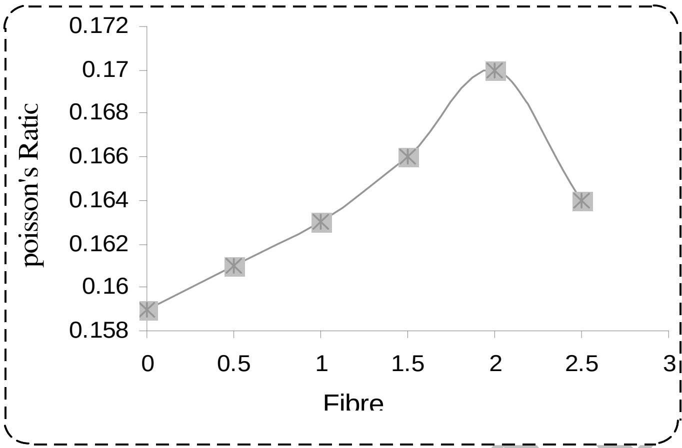

Figure 10. Poisson’s ratio variation

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