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PERMEABILITY AND DURABILITY STUDIES OF HIGH VOLUME FLY ASH GREEN CONCRETE UNDER AN APPLIED COMPRESSIVE STRESS.

Ramesh Tudu[1], Prof. Lal Mohan Mahto[2], Prof. Khushboo Tirkey[3]

[1]*M.Tech Student, Cambridge Institution of Technology, Ranchi,Jharkhand, India*
[2]*Assistant Professor, Cambridge Institution of Technology, Ranchi,Jharkhand, India*
[3] *Assistant Professor, Cambridge Institution of Technology, Ranchi,Jharkhand, India*

Abstract - *Given their smaller carbon footprint and frequently higher life cycle performance than traditional portland cement combinations, high-volume fly ash (HVFA) cementitious composites (paste, grout, mortar, and concrete) have received much research as a class of sustainable materials. Research on HVFA-based materials has grown recently, and this has greatly improved the potential of these mixes for use in engineering applications. With an emphasis on the pertinent articles released over the past ten years, this work evaluates the updated knowledge of HVFA mixes in this context. It is investigated how the fresh characteristics, mechanical properties, durability performance, and environmental impact of HVFA cementitious composites are affected by replacing cement with an HVFA binder. Measures that potentially address the primary issues preventing the widespread use of HVFA mixes. In-depth discussion is given regarding countermeasures for the primary problems that prevent HVFA mixtures from being used more widely. Finally, we list the research gaps and HVFA's lingering difficulties.The term "green concrete" refers to concrete that has additional measures taken in the mix design and placement to ensure a sustainable structure and a long life cycle with a low maintenance surface, such as energy saving, CO2 emissons, and wastewater. "green concrete" is a revolutionary concept that uses concrete wastes that are environmentally friendly.*

***Key Words*:** High-volume fly ash (HVFA),Portland Cement, Greeen Concrete, Cementitious composites.

1.INTRODUCTION

The second most used substance in the world after water is cement concrete, which is the most frequently used man-made building material. It is made by combining the necessary amounts of cementation ingredients, water, aggregates, and occasionally admixtures. Concrete is created when the slurry is poured into molds and given time to cure. The long-lasting chemical reaction between water and cement causes the hardening, which results in the concrete becoming stronger over time. The cement-filled larger and smaller aggregate gaps in the cured concrete can alternatively be thought of as artificial stone. In a concrete mix the cementations material and water form a paste called cement water paste which in addition to filling the voids of fine aggregate, coats the surface of fine and coarse aggregates and binds.

Fly ash concrete is able to continue to strengthen over time because of the extra binder created by the reaction of the fly ash with the available lime. In the end, mixtures created to provide equivalent power at young ages (less than 90 days) will be stronger. Fly ash offers various advantages and enhances the performance of Portland cement concrete (PCC) in both the fresh and hardened states. The use of fly ash in concrete enhances both the strength and durability of hardened concrete as well as the workability of plastic concrete. Utilizing fly ash is also economical. The amount of Portland cement in concrete may be decreased if fly ash is added.

1.1 Why Fly Ash

1) Fly ash, the main by-product of coal combustion in thermal power plants, is one of the most commonly used supplementary cementitious materials (SCMs) in concrete.
2) The global annual generation of coal combustion products is approximately 1.1 billion metric tonnes, more than 85% of which is fly ash, resulting in about 935 metric tonnes of fly ash produced every year.
3) Fly ash is a finely divided waste product resulting from the combustion of pulverized coal in power plants. It contains large amount of silica, alumina and small amount of unburned carbon, which pollutes environment.
4) It is grey in colour and alkaline in nature.
5) The particle size ranges between 5-120 microns.
6) When used in concrete, it displaces more than 25% of cement.
7) Creates a more stronger bond.
8) Reduces concrete’s environmental impact.

1.2 why Greeen Concrete

Green concrete is a type of regular concrete that either employs recycled materials, incorporates environmentally friendly components, or performs better than regular concrete over time, minimizing the need for replacement in the future.

Since cement is the most major producer of CO2 emissions in concrete, many have concentrated on substitutes to minimize the quantity of cement used per batch, including industrial waste products from foundries, quarries, power plants, feed mills, and other sources. There are, however, a number of aggregate substitutes, such as glass, waste plastic, and recycled concrete. Companies can save water by adding superplasticizers or other water-reducing admixtures to concrete in addition to replacing different types of cement, aggregate, or sand, which will reduce the amount of water used during the concrete pouring process.

2.AIM AND OBJECTIVE

• To create a test procedure that can assess concrete's water permeability while it is being stressed.

• To investigate the workability effects of high volume fly ash.

• To research the impact on compressive strength of concrete.

• Comparison of the outcomes of various tests with variable HVFA proportions.

3. METHODOLOGY

1. The specimens must have a cylinder shape with a height that is equivalent to their diameter. The standard specimen size must have a 150 mm diameter and height. The diameter (and height) of specimens comprising aggregates with nominal sizes no greater than 20 mm may be decreased to 100 mm. The diameter (and height) of the specimen, in the case of specimens having aggregates with nominal sizes greater than 40 mm, should not be less than approximately four times the nominal size of the aggregate.

2. Split molds of the requisite size must be used to cast the mortar or concrete mixture, and the top of the molds must have a removable collar that is roughly half the height of the mold. According to the suggested methods during construction, the material must be compressed either manually or vibratorily. The collar must then be removed, and the mold must be leveled with a straight edge using a sawing action without any additional trowelling or finishing, which could bring the fines to the surface. If the engineer-in-charge doesn't specify differently, the specimen must be cured for 28 days.

3.1 Pressure Head

1. The water in the reservoir should be subjected to a standard test pressure head of 10 kg/cm2. However, for relatively more permeable specimens where steady state of flow can be achieved in a reasonable amount of time, this can be lowered up to 5 kg/cm2, and it can be increased up to 15 kg/cm2 for relatively less permeable specimens where sealing can be guaranteed to be totally effective.
2. The reservoir must be filled with water when the air bleeder valve is open, the reservoir drain-cock is closed, and the shut-off valve between the reservoir and the cell is closed. The reservoir drain-cock must then be opened to release any trapped air before being shut once more. The bleeder valve must be closed, the reservoir refilled to a level above the gauge-glass scale's zero position, and the necessary air pressure provided. To get the water level to zero, cautiously open the drain cock, then quickly close it. After that, water must be drained and collected in 250 ml increments in a graduated jar, and the gauge-glass level must be read on the scale. The calibration constant for the reservoir shall be expressed in millilitres per division of the scale.

3.2 Sealing of Test Specimen

1. Surface-dry the specimen, and measure the dimensions to the nearest 0.5 mm. The lower end should then rest on the ledge and it should be centered within the compartment. A cotton or hemp string saturated in a suitable molten sealing compound and tightly caulked to a depth of about 10 mm is required to seal the annular area between the specimen and the cell. The molten sealing compound needs to be carefully poured into the remaining area until it reaches the top of the specimen. Any level drop brought on by cooling must be made up for by remelting the solidified compound with a heated rod and then covering it with fresh material. A seal can be created by applying hot beeswax and rosin mixtures.

2. Examining the Seal 1. It's crucial for the seal to be watertight. By bolting on the top cover plate, inverting the cell, and applying an air pressure of 1 to 2 kg/cm2 from below, this may be confirmed quite conveniently. A little amount of water is placed on the specimen's exposed face to check for any seal leaks, which would manifest as bubbles along the ledge. The specimen must be removed and resealed if there are leaks.

3. Putting the apparatus together 1. After achieving a reliable seal, the funnel must be fixed in place and the cell assembly must be linked to the water reservoir. De-aired water must be allowed to enter the reservoir with the air bleeder valve, the valve between the reservoir and the cell, and the drain-cock inside the cell all open. When water flows freely via the drain-cock, the valve must be closed and water must be added to the water reservoir. Then, the air bleeder and reservoir water inflow valves must be shut off.

4. Executing the Exam 1. The necessary test pressure should be applied to the water reservoir once the system has been fully filled with water, and the gauge-glass's initial reading should be noted. A clean collecting bottle must be weighed and positioned to catch the water trickling through the specimen at the same time. At regular intervals, the amount of percolate and the gauge-glass readings must be recorded. The rate of water intake initially exceeds the rate of outflow. The two rates tend to equalize as the steady state of flow approaches, the outflow reaches its maximum, and the flow stabilizes. Permeability test shall be continued for about 100 hours after the steady state of flow has been reached and the outflow shall be considered as average of all the outflows measured during this period of 100 hours.

Calculation

The Coefficient of Permeability shall be calculated as follows: $K = Q / (A*T*H/L)$ where, K= Coefficient of permeability (cm/sec),

Q= quantity of water in millimeters percolating over the entire period of test after the steady state has been reached,

A= area of the specimen face in cm2,

T= time in seconds over which Q is measured, and

H/L= ratio of the pressure head to thickness of specimen, both expressed in the same units.

Sample	**1**	**2**	**3**
Ingredient	Plain concrete	15% fly ash	20% fly ash
Cement (kg/m3)	400	300	200
Water (kg/m3)	160	160	160
W/C ratio	0.4	0.4	0.4
Fly Ash (kg/m3)	0	100	200
Aggregate (kg/m3)	850	850	850
Sand (kg/m3)	850	850	850

Table 4.1:- Concrete mix proportions

Sample	**1**	**2**	**3**	**4**
Age (day)	1	1	3	3
Compressive strength (MPa)	11.40	10.70	27.70	26.30
	10.90	12.40	26.40	27.70
	11.70	10.50	26.00	25.80
Average	11.46	11.53	25.03	24.93
Standard deviation (MPa)	0.48	0.68	0.54	0.59
Coefficient of variation (%ge)	4.70	6.50	2.00	2.30

Table 4.2:- Compressive strength

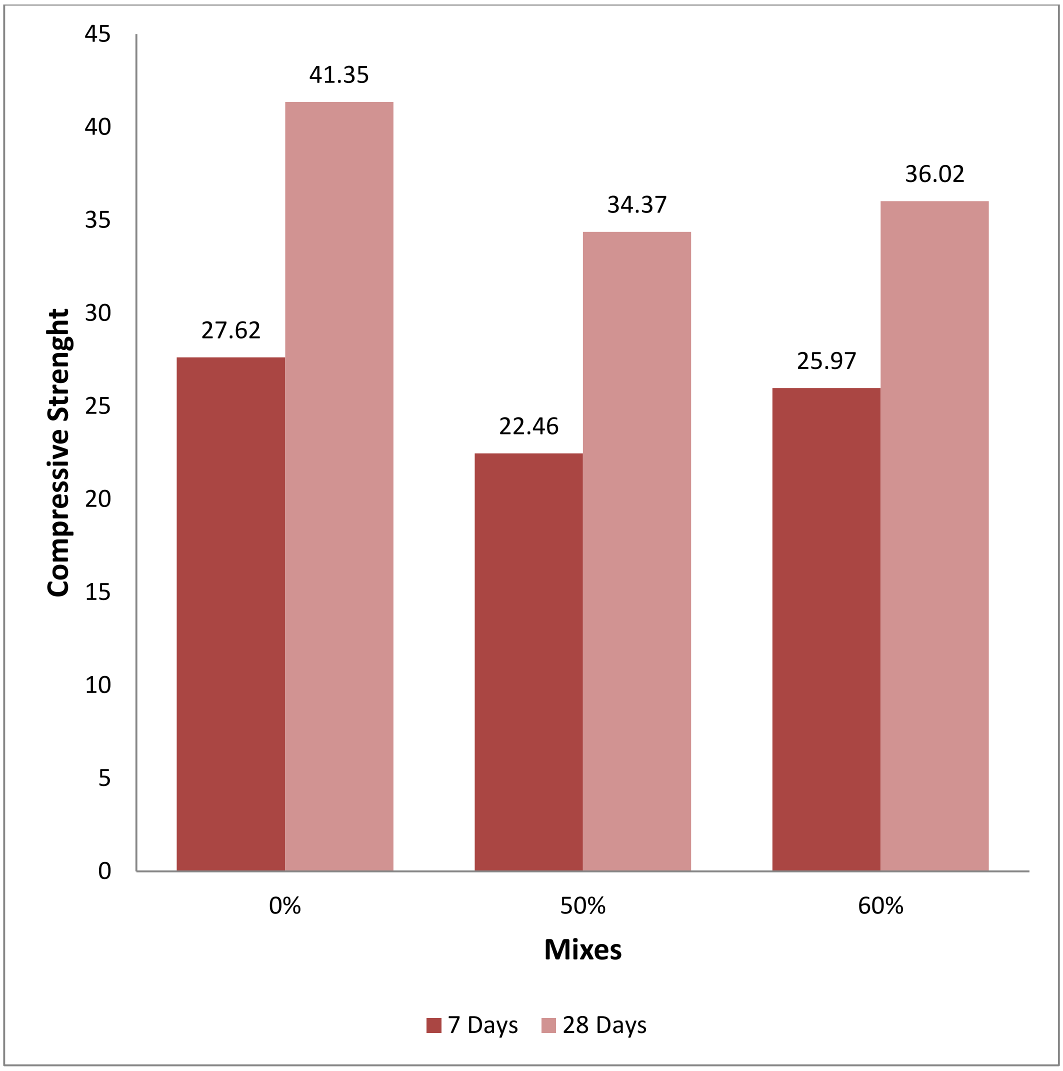
1) RESULTS AND DISCUSSIONS

Compressive Strengths

Compressive test is used to find the stability to resist the compression load on the specimen or material before fracturing so as to obtain strength of the material. Generally, compressive strength on concrete depends on many factors like water to cement ratio, quality of materials, strength of cement etc. Compressive strength values of 15cmx15cmx15cm cubes for all the eight mixes for target strengths 30MPa and 40MPa at 7 and 28 days .

Day	0% FLY ASH	50% FLY ASH	60% FLY ASH
7	27.62	22.46	25.97
28	41.35	34.37	36.02

Table 5.1:- Compressive strengths at different days of curing



CONCLUSION

Concrete with high percentages of fly ash is produced to have a high strength besides good durability. Generally, durability is attributed by performing tests on permeability.

- The data obtained from tests clearly show that there is a rapid increase of compressive strength at 28 days for plain concrete as well as fly ash concretes by reaching the target strengths.
- The results show that at 28 days the strengths of HVFA concretes remarkably improved up to 60% for both the grades.
- Compressive strengths for M30 grade concrete shown that there is an equal strength for both 50% and 60% of replacement by fly ash.
- There is a drastic reduction in chloride ion permeability in the case of HVFA concretes compared to plain concretes. It has been observed that permeability reduces as fly ash percentage increases in concrete.
- At 60% replacement by fly ash the compressive strengths and resistance to chloride ion penetration are very high for both M30 replacements including plain concrete.
- This lateral reduction in permeability of concrete tends to achieve greater durability conditions.

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