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Experimental Study on Partial Replacement of Cement by Fly Ash With Addition of Pva Fiber in Concrete

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ABSTRACT
Today's world places a strong emphasis on environmentally friendly and sustainable development. Thermal power plants currently produce a lot of fly ash as waste, which has negative effects on both the environment and people. Thermal power plant waste called fly ash is a major environmental hazard. For this investigation, M20 grade concrete is used. The primary goal of this research is to determine whether fly ash may substitute cement and provide additional strength for PVA fibers in concrete. PVA fibers comprise a constant 0.1% by weight of cement's extra reinforcing. Using cementitious materials, PVA fiber exhibited excellent dispersibility, superior bonding capabilities, and increased tensile strength without increasing compressive strength. In the range of 0% (without fly ash), 5%, 10%, 15%, & 20% by weight of cement for M-20 mix, fly ash has been used to substitute cement in the appropriate amounts. These tests were conducted to assess the mechanical characteristics, and the compressive strength test data for 7, 14, and 28 days were collected**.**

KEYWORDS-- PVA (Polyvinyl alcohol) Fiber, Fly Ash, Compressive strength

I. INTRODUCTION

Using industrial and agricultural waste is necessary for sustainable development and the production of greener concrete in the building sector. The concrete construction industry is currently unsustainable for a variety of reasons. It primarily needs a huge quantity of virgin materials, which future generations may also need. Second, Portland cement serves as the primary binder in concrete. The production of Portland cement results in enormous emissions of carbon dioxide, which is a major contributor to the effects of greenhouse gases and contributes to climate change and global warming.Another crucial factor is the fact that so many concrete structures have durability issues, which might waste natural resources. Hence, using industrial and agricultural waste materials to partially replace port land cement appears like a good answer for sustainable growth in the now and the future. Fly ash is one of the most significant and appropriate sources of mineral admixture among industrial waste materials since it is widely available and has a reasonably high silica content.

The polyvinyl-alcohol (PVA) fibers are a type of fiber manufactured from polyvinyl alcohol through wet spinning, heat treatment, and mechanical qualities like high strength, high elastic modulus, and low ductility. The PVA fibers also have excellent chemical resistance, great corrosion resistance in harsh settings, and high dimensional stability against heat and moisture. Especially, PVA fibers show a strong affinity for cement and polymers.

II. MATERIALS AND PROPERTIES

2.1. Cement

For the investigation, Ordinary Portland Cement of grade 53, which is generally accessible, was chosen. The used cement was dry, powdery, and lump-free. While storing cement, any moisture contact was completely avoided. The test results for cement's characteristics are displayed in Table 1.

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Table 1. Properties of Cement (OPC 53)

S.NO	Properties	Cement
1.	Specific gravity	3.10
2.	Standard consistency	30%
3.	Initial setting time	60 minutes
4.	Final setting time	320 minutes
5.	Fineness (%)	6

2.2. Fine Aggregate

Concrete's primary component, aggregate, gives the material volume. Since it is chemically inert, it gives concrete strength and longevity. M-sand that passes through a 4.75mm screen is used as fine aggregate. The parameters of fine aggregates tested for are displayed in Table.2.

Table 2. Properties of Fine aggregate

S.NO	Properties	Fine Aggregate
1.	Specific gravity	2.35
2.	Water absorption	1.20
3.	Fineness (%)	3.30

2.3. Coarse Aggregate

As coarse aggregate, natural crushed stone with a 20mm minimum particle size was employed. The test results for the coarse aggregates' characteristics are displayed in Table 3.

Table 3. Properties of Coarse Aggregate

S.NO	Properties	Coarse Aggregate
1.	Specific gravity	2.54
2.	Water absorption	0.38%
3.	Fineness (%)	7.4

2.4. Fly Ash

The non-combustible mineral part of coal is what makes up fly ash. One of the byproducts of combustion is fly ash, which is made up of the tiny particles that rise with the flue gases. Ash that does not rise is referred to as bottom ash. Fly ash often refers to the ash created during coal combustion in industrial settings. The test findings for Fly ash's characteristics are shown in Table 4.

Table 4. Properties of Fly Ash

S.NO	Properties	Fly Ash
1.	Specific gravity	2.50
2.	Fineness (%)	2.25

2.5. PVA Fiber

For this project, we used Poly Vinyl Alcohol fiber that we bought from Spinning King India Ltd. in Ahmadabad. Compared to other organic fiber, this PVA fiber has a high tensile strength and elastic modulus. Table 5 displays the Polyvinyl Alcohol Fiber's manufacturer-provided characteristics.

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Table 5. Properties of PVA fiber

S.NO	Properties	PVA Fiber
1.	Diameter (mm)	0.1
2.	Length (mm)	13
3.	Shape	Straight round
4.	Density (g/m3)	0.9
5.	Tensile Strength (MPa)	1200
6.	Aspect ratio	130

2.6. Super plasticizer

In this study, a super plasticizer called Conplast SP430, which is readily accessible, was used.

2.7. Water

Generally speaking, water fit for drinking can be used to mix concrete. Water impurities may influence the concrete's strength, shrinkage, and setting time as well as encourage reinforcement corrosion. Hence, the task was done with drinking water that was locally accessible and filtered.

III. DESIGN MIX METHODOLOGY

3.1. Mix Design

The test samples were created with a mix M20 grade that adhered to IS 10262:2009. In this experimental study, weight batching and mechanical mixing are used. Table 6 displays the weight of their materials as well as the percentage of FA and PVA fibre added in place of standard cement.

Table 6. Mix Proportion per Cube meter

S.NO	Cube Type	Concrete Design Mix Proportion (By Weight)				FA (Fly Ash)	PVA fiber
		C (kg)	F.A (kg)	C.A (kg)	W/C ratio	(kg)	(gm)
1.	C1	1.50	2.25	4.5	0.42	-	-
2.	C2	1.42	2.25	4.5	0.42	0.075	1.5
3.	C3	1.35	2.25	4.5	0.42	0.150	1.4
4.	C4	1.27	2.25	4.5	0.42	0.225	1.3
5.	C5	1.20	2.25	4.5	0.42	0.300	1.2

Note: C1 (Control Cube), C2 (5% FA+ 0.1% PF), C3 (10% FA+ 0.1% PF),C4 (15% FA+ 0.1% PF),C5 (20% FA+ 0.1% PF)

3.2. Compressive strength test

The most frequent test on concrete is the compressive strength test because it is a measure of the desirable characteristics of concrete that are quantitatively connected to its compressive strength. Compressive Testing Machine (CTM) with a 2000 kN capacity was used to measure compressive strength. Concrete's compressive strength was evaluated using cube specimens of 150 mm by 150 mm by 150 mm. The test was conducted by sandwiching a specimen between a CTM's loading surfaces, then applying load until the specimen broke.For each proportion, three test specimens were cast, and the compressive strength was measured under each set of test conditions. The average value was taken into account. Below

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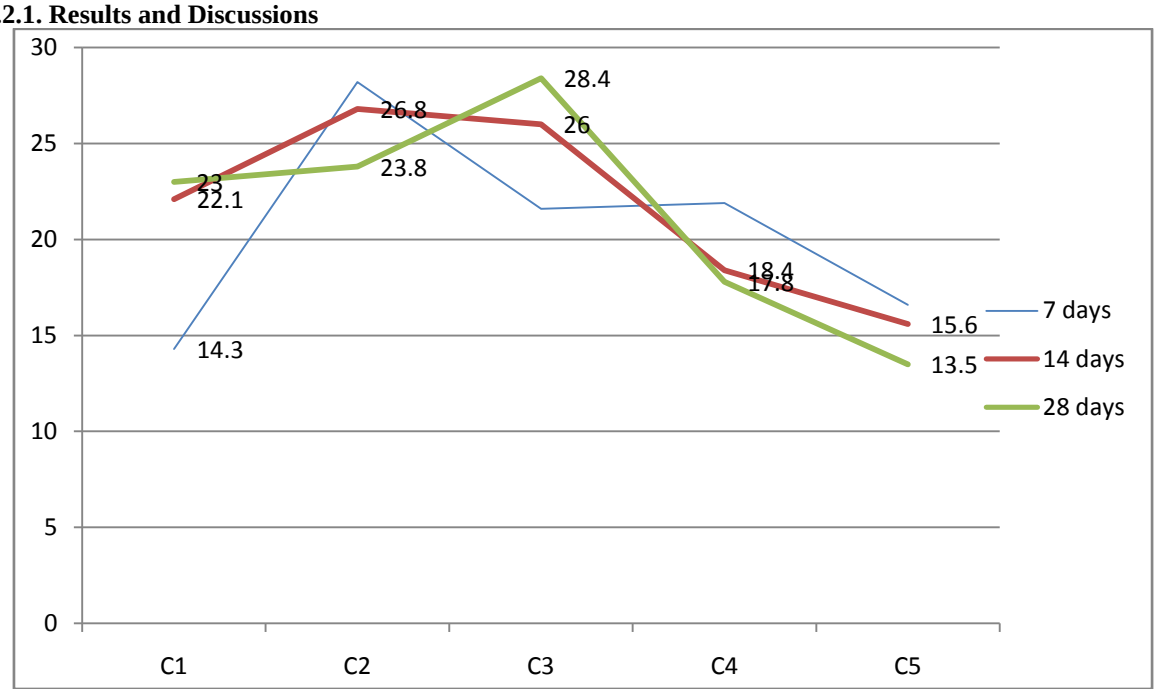
are three specimens' average compressive strengths at ages 7, 14, and 28 days for each category.

3.2.1. Results and Discussions



X-Axis: % of Fly Ash & PVA Fiber, Y-Axis: Compressive Strength (MPa)
Note: When the percentage of Fly Ash & PVA Fiber increases there is a gradual decrease in compressive strength of concrete.

IV. SUMMARY AND CONCLUSION

The characteristics of concrete containing fly ash and PVA fiber replacing some of the cement were investigated. The investigation of compressive strength was among them. Based on a code book, the mixing proportions employed in this investigation were created. The combination of Fly Ash and PVA Fiber results in an up to 10% replacement increase in compressive strength. The substance is a waste, thus it is simple to gather. In areas without a need for structural elements, it can be utilized to replace concrete. As a result, tests revealed that PVA Fiber and Fly Ash could replace up to 10% of cement without any adverse effects.

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