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Study of Strength of Concrete with doping of ceramic dust.

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ABSTRACT- Investigating the Influence of Ceramic Dust and Polypropylene Fiber on the Mechanical Properties of Concrete

This research focuses on the utilization of mineral admixtures such as ceramic dust, fly ash, and metakoline to produce high-performance concrete. The study examines the impact of ceramic dust percentage and polypropylene fiber on the mechanical properties of concrete. The aim is to understand the effects of substituting cement with ceramic dust, polypropylene fibers.

KEYWORDS- Ceramic Dust, Polypropylene Fibers, Concrete, Strength, Waste.

I. INTRODUCTION

The utilization of concrete and mortar as cost-effective, durable, and structurally strong building materials makes them highly desirable for construction . Their malleability in their fresh state allows for easy shaping according to specific requirements. However, the inherent weaknesses such as low tensile strength, susceptibility to moisture fluctuations, and vulnerability to failure necessitate the use of fiber reinforcement to overcome these limitations in a practical and affordable manner. Fiber reinforcement, especially with polypropylene fibers, significantly improves key qualities of these materials, including flexural strength, durability, fatigue resistance, impact permeability, and abrasion resistance. The ceramic industry faces challenges in waste disposal, with ceramic waste being irresponsibly dumped, leading to environmental pollution and land occupation issues. By incorporating ceramic waste into concrete, significant cost savings, energy efficiency, and reduced environmental impact can be achieved. Additionally, the development of new concrete technologies, such as using pozzolanic materials and nanotechnology, presents opportunities to reduce the reliance on natural resources and improve overall construction practices. By replacing cement with ceramic dust and polypropylene fibers, environmentally friendly building techniques can be realized, as demonstrated by the findings of this study.

The need for cost-effective methods to cope with the demands of expanding road networks in India is particularly crucial due to limited fiscal resources. Utilizing locally available soil as granular layers in pavement construction can significantly reduce construction costs. This approach involves the use of stabilizers, which offer an economical solution for pavement construction and maintenance. Addressing the issue of waste disposal generated by industries is another important aspect. By repurposing these waste materials for engineering purposes, the problems associated with disposal and environmental impact can be mitigated.

In a pavement section, bituminous layers are typically placed over a base and/or sub-base, which are compacted on a suitable subgrade. The soil subgrade plays a critical role in the pavement section, as inadequate bearing capacity can lead to rutting in the granular base and subbase layers, eventually resulting in fatigue cracking in the bituminous layers. Therefore, improving the properties and performance of the soil subgrade is essential for ensuring the longevity and stability of the pavement structure.

II. MATERIALS AND METHODS

In this study, OPC Grade 43 cement was selected as the type of cement used [22]. Fine aggregates were obtained from Standard Ennore sand, while crushed stone with a maximum graded aggregate size of 12.5mm was used. The concrete mixture adhered to the guidelines set by the Indian standard code IS 456-2000, which specifies the use of potable water for concrete production [23]. Sand classification was conducted following the standards outlined in IS 383 (1970). All materials were procured from local vendors, ensuring accessibility and availability. The concrete making and casting processes followed the procedures outlined in IS 516:1959, which was reaffirmed in 1999.

To ensure accuracy, the quantities of cement, coarse aggregates (20mm and 10mm size), fine aggregate, and water were individually weighed for each batch, with a precision of 0.1 kilogram. For testing the compressive strength, cube specimens measuring 150 millimeters in length were used, as specified by the Indian standard specifications BIS: 516-1959. The splitting tensile strength was measured on cylindrical specimens with a diameter of 150 millimeters and a length of 300 millimeters after 7, 28, and 90 days of ageing, following the recommendations of the Indian standard specifications BIS: 516-1959.

Table 1: Mix proportion for ceramic dust & polypropylene fiber per m3 concrete

Designation	Cement (kg)	Sand (kg)	Coarse Aggregate (kg)	Ceramic dust(%)	Ceramic dust(kg)	Polyproplene fiber(%)	Polyproplene fiber(kg)	Water (L)
CM0	300	735	1245	0	0	0	0	135
CM1	285	735	1245	5	15	0	0	135
CM2	270	735	1245	10	30	0	0	135
CM3	255	735	1245	15	45	0	0	135
CM4	240	735	1245	20	60	0	0	135
CM5	254.25	735	1245	15	45	0.25	0.75	135
CM6	253.5	735	1245	15	45	0.5	1.5	135
CM7	252.75	735	1245	15	45	0.75	2.25	135
CM8	252	735	1245	15	45	1	3	135

III. RESULT AND DISCUSSIONS

A. *Workability*

The addition of ceramic dust to the concrete mixture has a detrimental effect on its workability. The results of the slump cone test revealed that the workability of the control mix was 95 millimeters. However, as ceramic dust was gradually incorporated, the workability gradually decreased, reaching a minimum value of 75 millimeters when 20 percent ceramic dust was added. This reduction in workability can be attributed to the small particle size of the ceramic dust [14].

Furthermore, even a small percentage of polypropylene fibers exacerbates the decline in workability, with a workability value of only 51 millimeters when 1.0 percent of polypropylene fiber is added. This decrease in workability can be attributed to increased particle packing and enhanced intermolecular forces resulting from the presence of the fibers. As the fibers act as fillers and reinforcing materials, their inclusion ultimately leads to a loss in workability [24] (Figure 1).

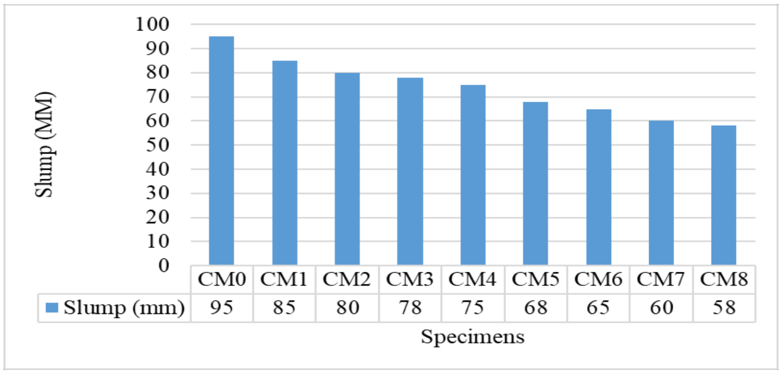

Figure 1: Variation of workability

B. Compressive Strength

Using a compression testing machine and 150-millimeter cubes, the compressive strength of the concrete mix was determined after 7, 28, and 90 days. A comparison with the control mix, which had no additives, revealed that the compressive strength increased in all mixtures and curing periods. At 7 days, the addition of 5 percent, 10 percent, 15 percent, and 20 percent ceramic dust resulted in a percentage increase in compressive strength of 2.81 percent, 9.71 percent, 13.98 percent, and 13.13 percent, respectively. At 28 days, the percentage increases were 2.48 percent, 6.67 percent, 11.61 percent, and 5.42 percent, and at 90 days, they were 4.96 percent, 7.63 percent, 14.82 percent, and 6.73 percent, respectively.

The improvement in compressive strength in the concrete containing ceramic dust can be attributed to enhanced packing percentage and reduced voids. This led to an enhancement in the microstructure and improved binding between the aggregate and the paste. The addition of ceramic dust improved the link between the sand, aggregate, and the hydrated cement matrix, resulting in an increase in compressive strength (Figure 2).

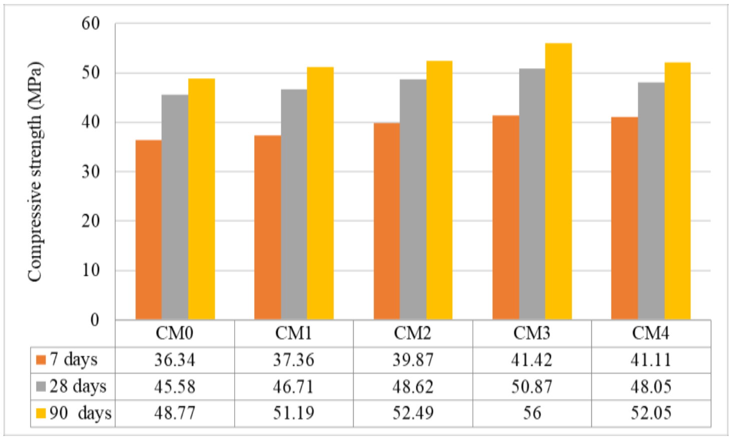

Figure 2: Variation of compressive strength with addition of ceramic dust

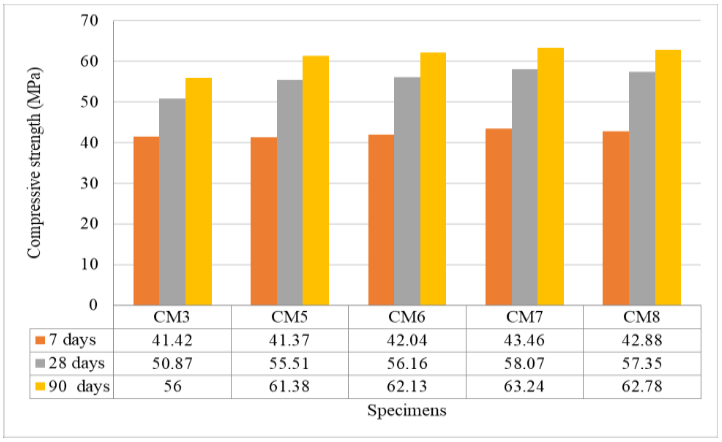

Figure 3: Variation of compressive strength with addition of polypropylene fibers

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