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EXPLORATION AND COMPARISON BETWEEN REGULAR CONCRETE AND CONCRETE WITH MINERAL ADDITIVES

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Abstract: Concrete is a fundamental building material with critical properties such as durability, strength, and versatility. In recent years, there has been increasing interest in enhancing concrete performance and sustainability by incorporating mineral additives such as fly ash, slag, and silica fume. This study explores and compares the characteristics of regular concrete and concrete with mineral additives to evaluate their suitability for various construction applications. The research focuses on the mechanical properties, durability, and environmental impacts of both types of concrete. Laboratory tests will be conducted to compare the compressive strength, tensile strength, resistance to freeze-thaw cycles, chemical attacks, and workability of regular concrete and concrete with mineral additives. Additionally, life cycle assessments will be performed to analyze the environmental implications of using mineral additives in concrete production. One of the main advantages of mineral additives is their potential to improve the strength and durability of concrete. Fly ash, slag, and silica fume have been shown to enhance long-term strength, reduce permeability, and increase resistance to chemical attacks in concrete mixtures. Furthermore, using mineral additives can reduce the reliance on cement, a primary component of concrete with a significant carbon footprint, leading to reduced greenhouse gas emissions and resource depletion.

***Index Terms* – Concrete, Mineral additives, Durability, Strength.**

I. INTRODUCTION

Concrete is a construction material made of a mixture of cement, sand, stone, and water that hardens to a stone like mass. A mass formed by the coalescence of separate particles. Concrete is a composite material composed of coarse aggregate bonded together with a fluid cement that hardens over time. Most concretes used are lime -based concretes such as Portland cement concrete or concretes made with other hydraulic cements. When aggregate is mixed together with dry Portland cement and water, the mixture forms a fluid slurry that is easily poured and molded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses. Often, additives (such as pozzolans or superplasticizer) are included in the mixture to improve the physical properties of the wet mix or the finished material. Most concrete is poured with reinforcing materials (such as rebar) embedded to provide tensile strength, yielding reinforced concrete.

1. Concrete

Concrete is a versatile construction material made from a mixture of cement, water and aggregates, including sand, gravel and crushed stone. It is one of the most widely used materials in construction due to its durability, strength and affordability. Concrete can be poured into molds or forms to create a variety of structures such as buildings, bridges, roads and dams. It can also be reinforced with steel bars to increase its strength and resistance to tension. Concrete is a key component in modern construction and plays a crucial role in shaping the built environment around us.

2. Glass Fiber

Glass wool, which is commonly known as "fiberglass" today, however, was invented in 1938 by Russell Games Slater of Owens-Corning as a material to be used as insulation. It is marketed under the trade name Fiberglas, which has become a generalized trademark.

Glass fiber is commonly used as an insulating material. It is also used as a reinforcing agent for many polymer products; to form a very strong and light fiber-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), popularly known as "fiberglass". Glass fiber has roughly comparable properties to other fibers such as polymers and carbon fiber. Although not as strong or as rigid as carbon fiber, it is much cheaper and significantly less brittle.

3. Fly Ash

Fly ash is a waste generated by thermal power plants. it is the best know “pozzolana “in the word. and one of the most commonly used. Fly ash is used as a septenary cementitious material (SCM) in the production of Portland cement concrete.

Fly ash is the most important by-product of the combustion of coal. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with
bottom ash removed from the bottom of the boiler

II. LITERATURE REVIEW

Fly ash, a byproduct of coal combustion, has been widely used as a mineral additive in concrete due to its pozzolanic properties. It has been reported to improve the mechanical strength of concrete, reduced permeability and enhanced durability characteristics such as resistance to sulfate attack and alkali silica reaction. In addition, the use of fly ash in concrete can lead to a reduction in environmental impact by minimizing the use of cement, which is a significant source of greenhouse gas emissions.
Glass fiber, on the other hand, is a synthetic mineral additive that is used to improve the tensile strength and ductility of concrete. Studies have shown that the inclusion of glass fiber in concrete mixes can enhance flexural strength, impact resistance and crack resistance. This can be particularly beneficial in applications where increased toughness and durability are required, such as in infrastructure projects or earthquake resistant structures.
In one study, we investigated the effects of incorporating fly, ash and glass fiber in concrete mixes by varying the water to cement ratio. Different mixed designs were tested, including mixtures with water to cement ratios of 0.45 and 0.50. Mechanical tests such as compressive strength and flexural strength. Were carried out to assess the performance of the concrete mixes with mineral additives compared to regular concrete.
The results of the study indicated that the addition of fly ash and glass fiber improved the mechanical properties of the concrete mixes with higher strength and enhanced durability. Furthermore, the workability and real logical properties of the mixes were also evaluated, showing. Potential benefits in terms of easier placement and finishing of the concrete.
While the use of mineral additives like fly ash and glass fiber in concrete mixes shows promise in improving performance and sustainability, further research is needed to optimize mixed designs, assess long term performance and evaluate the economic feasibility of incorporating these additives overall. The literature supports the potential of mineral additives to enhance the properties and performance of concrete and construction applications, offering a sustainable and durable alternative to traditional concrete mixes.

III. METHODOLOGY

SIEVE ANALYSIS - Sieve analysis of an aggregate is an index number which is roughly proposal to the average size of the particles in the aggregate. The course the aggregate the higher the fineness modulus.

By passing the sample downward through a series of standard sieves, each of decreasing size openings, the aggregates are separated into several groups, each of which contains aggregates in a particular size range.

SPECIFIC GRAVITY- Specific gravity is the ratio of the density of a substance to the density of a reference substance; equivalently, it is the ratio of the mass of a substance to the mass of a reference substance for the same given volume. Apparent specific gravity is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance.

MIXING OF CONCRETE- The following procedure is adopted for the mixing of concrete: -

1. Mix cement and sand thoroughly.
2. Add the waste tyer rubber shredding and mix it.
3. Now add the coarse aggregate.
4. Mix the dry mixture thoroughly to achieve a homogenous mixture.
5. Finally, add the calculated quantity of water into the dry mixture and –mix thoroughly to get homogeneous wet mix.

WORKABILITY TEST OF CONCRETE- According to Indian Standard (IS: 1199-1959), workability of concrete is that properties of concrete which determine the amount of internal work necessary to produce full compaction. In its simplest form, the term "workability" may be defined as the ease with which concrete may be mixed handled, transported, placed in position and compacted.

COMPRESSION TEST- Compressive strength is the capacity of a material or structure to withstand axially directed pushing forces. It provides data (or a plot) of force vs. deformation for the conditions of the test method. When the limit of compressive strength is reached, brittle materials are crushed. Concrete can be made to have high compressive strength, e.g. many concrete structures have compressive strengths in excess of 50 MPa. By definition, the compressive strength of a material is that value of uniaxial compressive stress reached when the material fails completely. The compressive strength is usually obtained experimentally by means of a compressive test.

IV. RESULT

The Following are results of some tests that were conducted during the research-

Sieve Analysis

Table 1: Result of sieve analysis of sand

S.no.	IS Sieve	Particle Size D (mm)	Mass retained(g)	% Retained	Cumulative % retained	% Finer
1	4.75 mm	4.75 mm	15.0	1.5	1.5	98.5
2	2 mm	2 mm	84.0	8.4	9.9	90.1
3	1.18 mm	1.18 mm	282.0	28.2	36.6	63.4
4	600 microns	600 microns	610.0	61.0	92.2	7.8
5	425 microns	425 microns	176.0	17.6	78.6	21.4
6	300 microns	300 microns	794.0	79.4	97	3
7	75 microns	75 microns	29.0	2.9	82.3	17.7

Specific gravity by Pycnometer

Table 2: Result of specific gravity of sand

S. No.	Particulates	Designation	1	2	3
1.	Mass of pycnometer	(M1)	650 g	650 g	650 g
2.	Mass of Pycnometer + sand	(M2)	1552 g	1286 g	1244 g
3.	Mass of Pycnometer + sand+ water	(M3)	2242 g	2079 g	2052 g
4.	Mass of Pycnometer + water	(M4)	1684 g	1684 g	1684 g

5.	Specific gravity		2.62	2.63	2.62
6.	Average specific gravity		2.623		

Workability Test

Table 3: Result of slump Value

Sl. No.	Fiber Added (%)	Slump Value (mm)
1	0.0	0
2	0.3	0
3	0.6	0
4	0.8	0

Compressive Strength Test

Table 4: Result of compressive strength Test

S. No.	Fiber Added (%)	Compressive Strength after 3 days in N/mm^2	Average Compressive Strength in N/mm^2	Compressive Strength after 7 days in N/mm^2	Average Compressive Strength in N/mm^2
1.	0.0	13.33	14.22	18.22	19.11
		14.22		19.11	
		15.11		20.00	
2.	0.3	18.22	19.26	26.22	26.67
		20.00		28.89	
		19.56		24.89	
3.	0.6	20.00	20.59	30.22	30.52
		21.33		29.78	
		20.44		31.56	
4.	0.8	21.33	22.22	33.33	33.63
		22.22		32.00	
		23.11		35.56	

Figure 1: Fly Ash

Figure 2: Fiber Reinforcement

Figure 3: Compression testing machine Figure 4: Sieve Analysis

V. Conclusion

Based on the experimental study on concrete mixes, the following conclusions could be made:

a) A reduction in bleeding is observed by addition of glass fibers in the glass fiber concrete mixes.

b) A reduction in bleeding improves the surface integrity of concrete, and reduces the probability of cracks.

c) The use of glass fibers significantly improves the compressive strength irrespective of affecting the workability of concrete mixes.

d) Maximum compressive strength is attaining in 1.0% addition of glass fiber. So, adding glass fiber up to 1.0% only not exceeds the limit.

Ultimate compressive strength of concrete goes on decreasing with increase in w/c ratio of concrete.

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