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EXPERIMENTAL INVESTIGATION ON AR GLASS FIBRE CONCRETE WITH WASTE FOUNDRY SAND

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ABSTRACT

This study investigates the effects of incorporating alkali-resistant (AR) glass fibers and waste foundry sand (WFS) into concrete, specifically focusing on the partial replacement of fine aggregate with waste foundry sand. The utilization of AR glass fibers aims to enhance the tensile strength and crack resistance of concrete, while waste foundry sand, an industrial byproduct, is employed to promote sustainability and reduce the consumption of natural sand. Concrete mixtures were prepared with proportion of 0.03% AR glass fibers by weight and different replacement levels of fine aggregate with waste foundry sand 5%, 10%, 15%, and 20% by weight). The mechanical properties of these mixtures were evaluated through compressive strength, Split tensile strength, and Ultrasonic pulse velocity tests.

KEYWORDS: AR Glass Fibers, Waste foundry sand, sustainability, Compressive Strength, Split Tensile Strength and Ultrasonic pulse velocity.

1. INTRODUCTION:

Using waste materials in concrete mixtures is one important way to get rid of solid waste from other sectors. Coarse gravel and a fluid cement that solidifies over time combine to form the composite material known as concrete. Most concretes that are used have a lime basis, such as Portland cement concrete or concretes that are made using several hydraulic cements. The most important building material is cement, and it's very likely that this material will continue to be important in the future. The materials used in building and engineering have to meet ever-increasing specifications. There are alternatives to wood, steel, and plastic in building that they must contend with in terms of quality, economy, productivity, and the environment. If concrete is resistant to weathering, chemical erosion, and other deterioration processes, it is considered durable.

Since industrial waste materials and byproducts are constantly growing, solid waste management has emerged as one of the major environmental concerns facing the world. Because land filling is becoming more and more expensive, using waste and byproducts has become a desirable alternative to disposal. Among these is waste foundry sand (WFS), an industrial by-product.

Around the world, the ferrous and nonferrous metal casting industries generate millions of tons of waste. Every year, India produces over 2 million tons of waste foundry sand. WFS is a significant byproduct of the metal casting industry and has long been utilized with success as a filler for vacant spaces. However, the rapidly rising costs of disposal make using waste foundry sand for land infill increasingly problematic.

Because GFRC offers so many benefits over traditional concrete, it is widely used in the building industry. It lessens concrete bleeding, enhances concrete homogeneity and surface integrity, and lowers the likelihood of cracks. In comparison to traditional concrete, GFRC is a lightweight material that lowers total costs (SaiKiran and Rao, 2016). According to research, GFRC has attained high levels of flexural, split-tensile, compressive, and workability strength. Alkaline resistant glass fiber reinforced concrete (ARGFRC) adds to the longevity of concrete by preventing rust and corrosion. The mechanical qualities, workability, and durability of concrete have all significantly improved with the inclusion of A.R. glass fibers. As per the mix fraction of 0% and 0.03% of AR glass fiber.

2. OBJECTIVES

1. The objective is to measure the concrete's resistance to water absorption, chloride penetration, and other environmental factors to ensure long-term performance and structural integrity.

2. This objective focuses on promoting sustainable construction practices by recycling industrial byproducts, thereby reducing environmental impact and conserving natural resources.

3. This includes evaluating improvements in compressive strength, tensile strength, and Ultra pulse velocity.

3. MATERIALS

3.1 Cement: OPC Cement is often found to give a stronger strength than other grades when comparing different cement grades. According to the Bureau of Indian Standards (BIS), cement’s grade number indicates the minimum compressive strength it should achieve in less than 28 days. By the end of the 28th day, OPC Cement 53 Grade cement needs to have a minimum compressive strength of 53MPa, or 530 kg/cm2.

3.2 Fine Aggregate: Fine aggregates are essentially natural sand particles that are extracted from the ground during the mining process. They can be any size of crushed stone particle that is ¼" or smaller. Because this aggregate's size, or grading, is what makes it common to describe to this product as 1/4' minus. Fine aggregate is defined as the material that passes through an IS Sieve of 4.75 mm. Sand in Grading Zone II: River.(Medium grain).

3.3 Coarse Aggregate: Coarse aggregate is defined as the aggregate that is kept above IS Sieve 4.75 mm. The typical maximum size is progressively 10–20 mm; however, self-compacting concrete has been known to use particle sizes of up to 40 mm or more. Generally speaking, gap-graded aggregates perform better than continuously graded aggregates, which may result in costly internal grader friction and decreased flow. When it comes to the properties of various aggregate forms, rounded aggregates improved flow due to reduced internal friction, whereas crushed aggregates typically increased strength due to the angular particles interlocking.

3.4 Waste foundry sand: locally sourced waste foundry sand. WFS was utilized to partially substitute natural river sand, or fine aggregate. Gray iron is the metal poured into the foundry. The sand was examined for a number of characteristics in compliance with IS 2386-1963, including bulk density and specific gravity.

3.5 AR Glass Fiber: Alkali-Resistant (AR) Glass Fibres are a type of glass fibre specifically designed to resist the degrading effects of alkaline environments. They contain a high level of zirconium dioxide (ZrO_2), which significantly enhances their durability and performance when exposed to alkaline substances such as those found in cement and concrete.

3.6 Water: Potable water, also known as water fit for human consumption, is typically utilized as mixing water. On the other hand, non-potable water sources can also be used, provided that they do not negatively impact the properties of concrete. Potable water can be used to mix and cure concrete. Water's PH ranges from 6 to 8.

4. EXPERIMENTAL INVESTIGATIONS:

4.1**Compressive Strength Results:** Test specimens must be 15 by 15 by 15 cm in size, and the nominal maximum aggregate sizes of the concrete to be tested cannot be greater than 20 mm. 7 and 28 days are usually enough time to analyze the concrete sample.

Table 1: Compressive Strength Results of Concrete with Partial Replacement of Fine aggregate by Waste foundry Sand.

S.No	% of Waste Foundry Sand	Compressive strength results, N/mm^2	
		7 days	28 days
1	0%	26.16	39.46
2	5%	28.72	41.15
3	10%	29.31	42.54
4	15%	31.73	45.21
5	20%	29.89	42.87

Table 2: Compressive Strength result on concrete by AR Glass Fibre.

S.No	AR galssfibre	Compressive strength results, N/mm^2	
		7 days	28 days
1	0%	26.16	39.46
2	0.03%	31.45	44.94

Table 3: Compressive strength of concrete for combined partial replacement of fine aggregate by 15% Waste Foundry Sand and addition of 0.03 % AR Glass fibre.

S.No	WF+ARGF	Compressive strength results, N/mm^2	
		7 days	28 days
1	0%	26.16	39.46
2	15% WF+0.03%ARGF	34.53	48.64

4.2 Split Tensile Strength Test: The loading surfaces of the compression testing equipment are separated horizontally using a typical test cylinder of concrete specimen, measuring 300 mm by 150 mm in diameter. Up to the point where the cylinder fails at its vertical diameter, the compression force is applied consistently and symmetrically along its length.

Table 4: Split tensile Strength Results of Concrete with Partial Replacement of Fine aggregate by Waste foundry Sand.

S.No	% of Waste Foundry Sand	Split tensile strength results, N/mm^2	
		7 days	28 days
1	0%	2.58	3.76
2	5%	2.79	4.08
3	10%	2.84	4.21
4	15%	3.32	4.74
5	20%	2.95	4.29

Table 5: Split tensile Strength result on concrete by AR Glass Fibre.

S.No	AR galssfibre	Split tensile strength results, N/mm^2	
		7 days	28 days
1	0%	2.58	3.76
2	0.03%	3.25	4.63

Table 6: Split tensile strength of concrete for combined partial replacement of fine aggregate by 15% Waste Foundry Sandand addition of 0.03 %AR Glass fibre.

S.No	WF+ARGF	Split tensile strength results, N/mm^2	
		7 days	28 days
1	0%	2.58	3.76
2	15% WF+0.03%ARGF	3.44	4.85

4.3 Ultrasonic Pulse Velocity Test: Pulse of Ultrasonic Wave Concrete's density and elastic modulus are the primary determinants of its velocity.

Table 7: Ultrasonic Pulse Velocity Results of Concrete with Partial Replacement of Fine aggregate by Waste foundry Sand.

S.No	% of Waste Foundry Sand	Ultrasonic Pulse Velocity Results, m/s	
		28 days	Quality of Concrete
1	0%	4484	Good
2	5%	4791	Excellent
3	10%	4878	Excellent
4	15%	5056	Excellent
5	20%	4927	Excellent

Table 8: Ultrasonic Pulse Velocity Results of Concrete by AR Glass Fibre.

S.No	% of AR Glass Fibre	Ultrasonic Pulse Velocity Results, m/s	
		28 days	Quality of Concrete
1	0%	4484	Good
2	0.03%	5092	Excellent

Table 9: Ultrasonic Pulse Velocity of concrete for combined partial replacement of fine aggregate by 15% Waste Foundry Sand and addition of 0.03 % AR Glass fibre.

S.No	WF+ARGF	Ultrasonic Pulse Velocity Results, m/s	
		28 days	Quality of Concrete
1	0%	4484	Good
2	15% WF+0.03%ARGF	5368	Excellent

5. CONCLUSIONS:

1. The Normal Concrete Compressive Strength Results for 7 and 28 days is 26.16 and 38.09 N/mm^2.
2. The optimum compressive strength results of concrete with a 15% partial replacement of fine aggregate by waste foundry sand are 31.73 N/mm² at 7 days and 45.21 N/mm² at 28 days.

3. The compressive strength results of concrete with the addition of 0.03% AR glass fibre are 31.45 N/mm² at 7 days and 44.94 N/mm² at 28 days.

4. The compressive strength results of concrete with a combined replacement using waste foundry sand as a partial replacement for fine aggregate and the addition of 0.03% AR glass fibre are 34.53 N/mm² at 7 days and 48.614 N/mm² at 28 days.\

5. The Normal Concrete Split tensile Strength Results for 7 and 28 days is 2.58 and 3.76 N/mm^2.

6. The optimum Split tensile strength results of concrete with a 15% partial replacement of fine aggregate by waste foundry sand are 3.32 N/mm² at 7 days and 4.74 N/mm² at 28 days.

7. The Split tensile strength results of concrete with the addition of 0.03% AR glass fibre are 3.25 N/mm² at 7 days and 4.63 N/mm² at 28 days.

8. The Split tensile strength results of concrete with a combined replacement using waste foundry sand as a partial replacement for fine aggregate and the addition of 0.03% AR glass fibre are 3.44 N/mm² at 7 days and 4.85 N/mm² at 28 days.

9. The Normal Concrete Ultrasonic pulse velocity Results for 28 days is 4484 m/s.

10. The optimum Ultrasonic pulse velocity results of concrete with a 15% partial replacement of fine aggregate by waste foundry sand are 5056 m/s at 28 days.

11. The Ultrasonic pulse velocity results of concrete with the addition of 0.03% AR glass fibre are 5092 m/s at 28 days.
12. The Ultrasonic pulse velocity results of concrete with a combined replacement using waste foundry sand as a partial replacement for fine aggregate and the addition of 0.03% AR glass fibre are 5368 m/s at 28 days.

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