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INNOVATIVE APPROACHES TO SUSTAINABLE CONCRETE: ALCOFINE 1203 AND STEEL SLAG AS ECO-FRIENDLY REPLACEMENTS

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Abstract:

Concrete, as the backbone of modern infrastructure, necessitates continual advancements to meet evolving sustainability demands. This research explores the combined effects of incorporating Alccofine 1203 and steel slag into concrete formulations, aiming to improve its mechanical properties and reduce environmental impact. Alccofine 1203, a metakaolin-based supplementary cementitious material, offers pozzolanic reactivity enhancing concrete strength and durability. Steel slag, a byproduct of steel manufacturing, presents an opportunity for sustainable resource utilization, serving as a potential partial substitute for conventional aggregates and cementitious materials.. To asses the compressive strength and split tensile strength for 28,56 and 90 days.

Keywords:

Alccofine 1203, Steel slag, Cementitious Material, Compressive Strength and Split Tensile Strength.

1. INTRODUCTION

One of the most widely used building materials in the world; concrete is always being improved to improve its sustainability and qualities. When concrete is produced traditionally, a lot of natural resources are used, mostly cement and aggregates, which degrades the environment and releases carbon emissions. The use of alternative aggregates and supplemental cementitious materials (SCMs) in concrete has gained popularity recently as a way to lessen these negative environmental effects while enhancing concrete performance.

Concrete production has seen the partial substitution of cement and coarse aggregates by steel slag, a byproduct of steel making, and high-reactivity metakaolin known as Alccofine 1203. Because of the pozzolanic qualities of Alccofine 1203, concrete mixes are more reactive, which improves their strength, durability, and workability. Steel slag, on the other hand, has the benefit of lowering the environmental imprint by recycling industrial waste while having mechanical and physical qualities comparable to conventional aggregates.

2. OBJECTIVES

(a) Evaluate the workability and setting time of concrete mixes incorporating Alccofine 1203 and steel slag to ensure that the addition of these supplementary materials does not adversely affect the concrete's handling properties or construction timelines.

(b) Assess the impact of partially replacing cement with Alccofine 1203 and coarse aggregates with steel slag on the mechanical properties of concrete, including compressive strength, and Split tensile strength.

3. MATERIALS

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1. Cement:- Cement is the main component of mortar, grout, and concrete and acts as a common binding agent in construction. A combination of limestone, clay, shale, iron ore, and other elements are often burned at high temperatures in a kiln to make clinker. After that, clinker is ground into a fine powder.

2. Fine aggregate:- Sand is a granular substance made up of particles with an average diameter of 0.075 to 4.75 millimetres (mm). It is sometimes referred to as fine aggregate. It is a basic component of mortar and concrete mixtures, mixed with coarse aggregate (such gravel or crushed stone) and cement.

3. Coarse aggregate:- Coarse aggregate refers to granular materials that typically range in size from 4.75 mm to 75 mm in diameter, while the maximum limit may vary depending on local regulations and needs. It is one of the main constituents of concrete, similar to sand and cement as well as fine aggregate.

4. Alccofine 1203:- Alccofine 1203 is known for its high reactivity and fineness, making it an effective additive for enhancing the properties of concrete while reducing its environmental impact through the reduction of cement consumption and carbon emissions.

5.Steel slag:- Steel slag is a byproduct generated during the production of steel, typically through the steelmaking process in blast furnaces or electric arc furnaces. It possesses similar physical and mechanical properties to conventional coarse aggregates like gravel or crushed stone but often exhibits higher hardness and angularity.

6. Water:- Mixtures of concrete often contain water, which has an impact on the properties of the hardened material such as strength, durability, and workability. Controlling the water-cement ratio, using an appropriate mix design, and following the right curing techniques are essential for producing long-lasting, high-quality concrete constructions.

4. TEST RESULTS

(a) Compressive Strength: The highest load or force that a material can bear when compressed (pressed or squeezed) before failing or breaking is known as its compressive strength.

To determine for 28,56 and 90 days.

Table 1 : Compressive Strength Results on Concrete With Partial Replacement of Cement With Alccofine 1203.

Sl.no	% Alccofine 1203	Compressive Strength Results,(N/mm^2)		
		28 days	56 days	90 days
1	0%	39.08	42.53	45.67
2	5%	42.87	46.68	50.12
3	10%	46.12	50.27	53.95
4	15%	43.51	47.42	50.91

Table 2: Compressive Strength Results on Concrete With Partial Replacement of Coarse Aggregate With Steel Slag.

Sl.no	% Steel Slag	Compressive Strength Results,(N/mm^2)		
		28 days	56 days	90 days
1	0%	39.08	42.53	45.67
2	20%	43.01	46.87	50.31
3	40%	46.09	50.23	53.98
4	60%	42.39	46.14	49.54

Table 3: Combined Replacements of Compressive Strength Results on Concrete With Alccofine 1203 and steel slag

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Sl.no	% of AF+ SS	Compressive Strength Results,(N/mm^2)		
		28 days	56 days	90 days
1	0%	39.08	42.53	45.67
2	10 % AF+40% SS	59.12	64.45	69.18

Split Tensile Strength: The split tensile strength of concrete is an important property that shows how resilient the material is to tensile strains and breaking. It is particularly significant in situations where tensile forces are expected to be applied to the concrete. To determine for 28,56 and 90 days.

Table 4 : Split Tensile Strength Results on Concrete With Partial Replacement of Cement With Alccofine 1203.

Sl.no	% Alccofine 1203	Split Tensile Strength Results,(N/mm^2)		
		28 days	56 days	90 days
1	0%	3.92	4.26	4.58
2	5%	4.25	4.62	4.96
3	10%	4.56	4.97	5.34
4	15%	4.37	4.76	5.12

Table 5: Split Tensile Strength Results on Concrete With Partial Replacement of Coarse Aggregate With Steel Slag.

Sl.no	% Steel Slag	Split Tensile Strength Results,(N/mm^2)		
		28 days	56 days	90 days
1	0%	3.92	4.26	4.58
2	20%	4.29	4.67	5.09
3	40%	4.58	5.02	5.36
4	60%	4.26	4.63	4.97

Table 6: Combined Replacements of Split Tensile Strength Results on Concrete With Alccofine 1203 and steel slag

Sl.no	% of AF+ SS	Split Tensile Strength Results,(N/mm^2)		
		28 days	56 days	90 days
1	0%	3.92	4.26	4.58
2	10 % AF+40% SS	4.89	5.34	5.72

5. CONCLUSIONS

1. The Normal Concrete of Compressive Strength results for 28 days,56 days and 90 days is 39.08, 42.53 and 45.67 N/mm^2.

2. The Normal Concrete of Split tensile Strength results for 28 days,56 days and 90 days is 3.92, 4.26 and 4.58 N/mm^2.
3. By 10% of **Alccofine 1203** as partial replacement with cement the Compressive Strength results for 28 days,56 days and 90 days is 46.12, 50.27 and 53.95 N/mm^2.
4. By 10% of **Alccofine 1203** as partial replacement with cement the Split tensile Strength results for 28 days,56 days and 90 days is 4.56, 4.97 and 5.34 N/mm^2.
5. By 40% of steel slag as partial replacement with coarse aggregate the Compressive Strength results for 28 days,56 days and 90 days is 46.09, 50.23 and 53.98 N/mm^2.
6. By 40% of steel slag as partial replacement with coarse aggregate the Split tensile Strength results for 28 days,56 days and 90 days is 4.58, 5.02 and 5.36 N/mm^2
7. By the combination of 10% of **Alccofine 1203** +40% of steel slag the Compressive Strength results for 28 days,56 days and 90 days is 59.12, 64.45and 69.18 N/mm^2.
8. By the combination of 10% of **Alccofine 1203** +40% of steel slag the Split tensile Strength results for 28 days,56 days and 90 days is 4.89, 5.34 and 5.72 N/mm^2.

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